CONTENTS.

PREFACE.

DURING last year the following notification was made public :—

ROYAL SOCIETY OF VICTORIA.—GOVERNMENT PRIZE ESSAYS, 1860.

The Council of the Royal Society of Victoria has to announce that the Government has placed at the disposal of the Council the sum of Six hundred pounds sterling, voted by the Legislative Assembly as PREMIUMS for ESSAYS. The Council has decided, with the sanction of the Government, that the premium to be awarded for the best Essay on each subject shall be One hundred and twenty-five pounds sterling, with a medal. The following subjects have been selected, viz. :—

1. On the Collection and Storage of Water in Victoria for Gold-Washing, Irrigation, Motive-Power, and General Water Supply; with reference also to the practicability of Artesian Wells in certain localities.
2. On Agriculture in Victoria, with special reference to the Geological and Chemical Character of Soils, to the Rotation of Crops, and to the Sources and Application of Manures.
3. On the Origin and Distribution of Gold in Quartz-Veins, and its Association with other Metals and Minerals, and on the most improved Methods for extracting Gold from its Matrices.
4. On the Manufactures more Immediately Required for the Economical Development of the Resources of the Colony, with special reference to those Manufactures the raw materials of which are the produce of Victoria.

Competitive Essays on the above subjects are required to be written in a legible hand, on foolscap paper, on one side only, and leaving a two-inch margin. The authors will attach mottos only to the Essays, and accompany each Essay with a sealed envelope, containing inside the name and address of the author, and on the outside the motto affixed to the Essay.

The Essays must be in the hands of the Honorary Secretary of the Royal Society on or before the 1st of October, 1860.

The Council will appoint, subject to the approval of Government, three judges, who may or may not be members of the Society, to decide on the respective values of the competitive Essays on each of the four topics named; but the Council reserves the power to withhold the premium in the case of any of the subjects, should the competitive Essays on that subject be considered unworthy of such a reward.

The Essays receiving premiums shall be considered the property of the Government.

Royal Society, Victoria-street,
Melbourne, March 28, 1860.

In accordance with this notification, Essays to the number of twenty-six were forwarded to the Royal Society, and after careful examination the following were adjudged to be the successful ones.

During the progress of these Prize Essays through the press, numerous and valuable additions were made by the Authors to the original text. In justice to the other competitors, these additions are printed in a different type, and take the form of appendices. The foot notes formed part of the original MSS. Several maps, woodcuts, and tabulated statements have also been introduced to elucidate the various subjects. These circumstances have combined to delay the publication of the Essays until a later period than was originally anticipated.

The subjects treated of in the Essays which follow relate to the further development or more economical use of the principal natural resources of the colony. While some of these have been already so fully realized as to have placed Victoria in a commanding position, it can scarcely be denied that others admit of still further development, and indeed demand

attention, if the progress of the country is to be at all commensurate in the future with that which has marked it during the last few years. Moreover, as increase of population requires that new sources of industry should be made known, these Essays are further designed to indicate the direction in which such sources may be found, by those whose unemployed labor or capital seek for a fresh outlet for profitable investment.

The first Essay treats of the collection and economical use of the Water Supply of the country, so as to render it more available than now, for the gold miner, the agriculturist, the manufacturer, and for general domestic and sanatory purposes. By collecting and storing the frequently superabundant waters, so as to ensure a more constant and less costly supply, valuable assistance will be given to existing industrial pursuits, many of which fail at present to be permanent and profitable mainly for want of this desideratum.

The second Essay is occupied with the Geological, and, to a certain extent, the Chemical Characters, &c., of the various Soils of the country, a correct knowledge of which alone can enable the agriculturist to carry on his operations with certainty of success when the original qualities of the soil have been exhausted, and it becomes necessary to add fertilizing agencies. To those (and they are many) whose farming operations are now conducted empirically, this Essay will be read with pleasure, and it is anticipated that the principles laid down in it may be followed with advantage.

The third Essay deals with an important branch of Gold Mining enterprise; and while, to some extent, necessarily

taken up with discussing the theories as to the formation of Quartz Veins, it yet enters into practical details which cannot fail to be of benefit to those engaged in quartz-mining pursuits, enabling them to conduct their operations with more economy, and to utilise what has often been hitherto considered the refuse of the mines, because of ignorance of its value, or the proper method of treating it with advantage.

The fourth Essay is occupied with the consideration of the Manufactures which may be necessary for the economical development of such resources as have been as yet but partially recognized in Victoria.

A proper degree of attention to the several matters treated of in these Essays will to some extent enable those, whether in Victoria or at a distance, who possess either knowledge or capital, or both, to judge of the fitness of Victoria as a field for the employment of labor or the investment of capital.

It is to be hoped, in conclusion, that this effort on the part of the Legislature will incite to a more careful study, and a more economical use of those vast resources which require but science and industry to develop, and that Victoria may become celebrated not only for her inexhaustible mineral wealth and fertile soil, but also for superior local manufactures and the quality of the raw materials she is destined to supply so largely for the industry of other countries.

JOHN MACADAM, M.D.,

Honorary Secretary to the Royal Society of Victoria.

Dec. 13, 1861

ESSAY

ON THE

Collection and Storage of Water

IN VICTORIA.

BY FREDERICK ACHESON, C.E.

ESSAY.

The development of the ample resources of this colony demands at the present time the most serious and careful attention. The fact that industrial pursuits have of late not yielded that large return of former years, indicates either that the natural resources have been diminished, or that the means of developing them are insufficient: the production of mineral wealth is dependent upon a precarious supply of water, which, in the most favorable years, is inadequate. The gold fields, long since stripped of their richer deposits, now present openings where only real industry, combined with ample appliances, will make them productive, while a vast extent of poor auriferous country remains deserted and unworked, which would yield profitable results from the judicious supply of water. That the yield of gold would be enormously increased is undoubted and admitted on all sides, while the capital invested would be highly reproductive, and that without taxing mining interests to any sensible extent, as the general surface of the auriferous districts is highly favorable for obtaining ample supplies of water for artificial storage both from its undulating and impervious nature, while in its general configuration abundant sites for reservoirs of large capacity are presented, which, in many cases would involve but little outlay in their construction. It is satisfactory to know that, notwithstanding the diminished rainfall, an ample supply will be always available for collection, if only from the contribution of periodical heavy rains which happen during the driest years. The question of water supply becomes thus practically limited to economical storage capabilities. This colony has a mean rainfall, scarcely inferior, if not fully equal to that of England, whose more favorable geological formations modify the flow of water so as to distribute it permanently throughout the

year. In Victoria the rain falls upon a generally impervious surface unsuited to its absorption, and hence passes rapidly to the sea, leaving the beds of watercourses dry for a certain part of the year. How to prevent this enormous loss which forms a serious drawback to mining, agricultural, and pastoral interests, forms a question of the highest importance to the industrial advancement of the colony.

RAINFALL.

The observations on the rainfall of Melbourne have been conducted firstly, during the years from 1846 to 1851 inclusive, by Mr. Archer; the mean result for the six years was 32 inches per annum, the lowest being 26 inches for the year 1847, and the highest 44½ inches for the year 1849, in the November of which there fell so much as 12 inches. The results obtained during the years 1855, 1856, and 1857, at the Surveyor-General's office, were nearly the same for each, being 28½ inches.

Professor Neumayer's observations from March, 1858, to February, 1859, give a mean rain for Melbourne of 21½ inches, and from March, 1859, to February, 1860, 21¾ inches.

The following table shews the results of observations throughout the colony hitherto published:—

Year.	Melbourne.	Geelong.	Williamstown.	Heathcote.	Yan Yean.	Ballaarat.	Beechworth.	Castlemaine.	Camperdown.	Portland.	Sandhurst.	Port Albert.
1846	29·69											
1847	26·25											
1848	33·75											
1849	44·25											
1850	26·98											
1851	31·90											
June 1855 to Jan. 1856	2·4 mean of 8 mths.											
Feb. 1856 to Jan. 1857	28·59	mean for 11 months 2·03										
1857 to 1858	28·55	21·79	24·10	20·31	27·50							
Mar. 1858 to Feb. 1859	21·69	17·36	..	23·78	..	24·47	30·87	19·54	27·97	27·30	mean for 11 months 2·24	mean for 8 months 2·89
Mar. 1859 to Feb. 1860	21·72											
Mar. 1860 to Sept. 1860	1·70 mean pr. mth.											

From this table it appears that not only there has been a considerable diminution in the amount of rainfall of late years in Melbourne, but also that the last two years of observation were unusually dry.

As the average rain of the interior, where observed, was over 25 inches during a year of this dry period, this amount may safely be assumed as within the general average, and sufficiently safe to base calculations of least supply upon.

This rainfall gives a mean result of 381,668,000 tons of water per day over the whole area of the colony.

AVAILABLE RAIN, DRAINAGE BASINS, Etc.

The proportion of this rain that drains off the surface, and thence by the watercourses reaches the sea, being the available rainfall, forms a most important feature in this inquiry, and is one unfortunately that has never been determined by any extended series of experiments; some light, however, may be thrown upon this subject by investigating the conditions of surfaces forming drainage basins relatively with the known or deduced discharges of water therefrom.

The disposal of the rainfall upon its descent upon the surface may be classed as follows: firstly, by surface moisture and evaporation; secondly, by absorption and filtration through porous formations originating springs; thirdly, by surface drainage into the watercourses forming the main portion available for collection and storage. The relative proportions of rainfall disposed in each case necessarily depends upon the geological nature and configuration of the receiving basins, a due consideration of which is all-important in investigating the sources of water supply.

A large proportion of the colony consists of sandstone and slate formation, highly contorted from upheaval, and covered frequently with vast plains of basalt, especially towards the west, and protruded by large masses of plutonic rock, principally towards the east.

The general surface of this formation is of an impervious, non-absorbent character, being covered with a stiff clay, the result of its own decomposition, and also with beds of cemented gravel and sand of a generally very impervious nature.

The immense area occupied by this formation as the surface

rock, and its necessarily undulating and steep character, combine with its superficial imperviousness to effect the rapid discharge of a large per-centage of the rain into the watercourses, and thence to the sea, at once causing destructive floods and subsequent drought from the sudden and intermittent nature of the discharge.

But while to this formation, consequently almost destitute of springs, may be mostly attributed the non-permanency of the streams, and the badly watered condition of a large portion of Victoria, it nevertheless forms the best gathering grounds for the collecting and storage of water, and discharges off its surface the largest per centage of rainfall, and is therefore well adapted in an economical point of view for the supply of storage reservoirs, which may therefore in this formation be constructed of smaller capacity than those fed from more porous basins.

Although it may be said that this formation has comparatively little capacity for absorbing water, and giving it out gradually in the form of springs owing to its retentive character, yet the beds of its leading valleys and watercourses are frequently covered with an alluvium of sandy clay and gravel of a highly absorbent character, resting immediately upon the surface of the rock and affording abundant supplies of water by sinking even in the dry seasons. To this source are the gold-fields frequently indebted for a supply of water during the summer months; the absorbent character of the alluvium effecting a capacity for the storage of water therein invaluable to the miner during the dry season, although presenting difficulties to mining operations during the winter.

Next to the clay-slate and sandstone formation the basalt plains occupy the largest area, covering a large proportion of the western half of Victoria: owing to their level character they discharge a comparatively small per centage of rainfall into their watercourses, which are few and far apart; being covered with a tolerably stiff clay they are not well adapted for absorption, hence a considerable amount of the rainfall rests upon the surface and is disposed in the form of swamps and lagoons having no outlet and subject to constant evaporation.

The counties of Ripon and Hampden consist almost exclusively of trap plains, and evidence by their comparative absence of minor watercourses the small amount of water drained off them into the creeks. A considerable area of the latter county is covered with

an immense number of lagoons and swamps which testify at once the general non-absorbent character of the soil and the small capacity of the basalt plains for surface drainage. The fact also that the creeks intersecting this formation although frequently along deep valleys have comparatively few and unimportant springs, insufficient in the dry season to effect a constant flow in the creeks, and whose locality is scarcely otherwise indicated than by the presence of salt in the waterholes, evidently the result of salt-springs from the basalt, testify to its meagre absorbent capacity. The general paucity of springs from the basalt formation is further evidenced by the generally dry beds of its creeks in the summer time, intersecting as they frequently do one hundred miles of country at levels considerably below the general surface of the plains, they could not fail to drain a regular and uniform supply of water from this formation were it stored therein to any considerable extent.

That, however, copious springs occasionally occur in this rock is apparent from the examples at Mount Rouse, in the county of Villiers, and at the source of the River Coliban; these however are probably the result of great volcanic action producing a more decidedly fissured character in the rock than in that of the basalt plains.

The primitive granitiform formations of Victoria form a most important feature in its geological structure, as being the source of nearly all the permanent streams, forming a considerable portion of the great dividing range, from Mount Disappointment eastwards; from them proceed the only truly permanent streams in the colony, embracing the rivers Mitta-Mitta, Little River, Ovens, Goulburn, and Yarra, with their tributaries, flowing to the north and west, together with the magnificent rivers of Gipps Land flowing towards the south.

The peculiar aptitude of these rocks for the storage of rain water, and its gradual emission was observed at the sources of the River Plenty in Mount Disappointment, and arises from the lodging of the water in its extensive fissures, while the surface of the rock is covered with a spongy decomposed vegetable soil, constantly generating fresh vegetation, the subsequent decay of which increases the peaty mass which is thus constantly accumulating; rain falling upon this spongy surface is readily absorbed and filtered through into the fissures beneath, from whence it but slowly

drains out at lower levels, from the external fissures being filled up with this spongy soil, and roots of plants, &c. The eastern source of the Plenty, when observed in the summer of 1855, delivered 12 cubic feet per second, solely under the above conditions. The Woori Yalloak Creek, a small tributary of the Yarra, only 20 feet wide, and supplied from springs in the Dandenong and adjacent ranges eastward, discharged in the summer of 1859, 50 cubic feet per second, (or about one-tenth of the whole Yarra discharge on same day at Melbourne), from similar sources, as it was not then (if at any time) affected by the melting of snow, or by surface drainage; and this creek forms a type, in an inferior degree, of the many constantly flowing tributaries of the Yarra, such as the River Don, Badgers' Creek, Running Creek, &c.; all of them, in the dry season, evidently the sole result of springs from granitiform rocks, and not from the melting of snow, which if it existed in the height of summer, could be easily seen on the exposed Dandenong, Plenty and other ranges, forming the sources of these streams.

But while to this cause may be attributed the permanent character of streams generally, another scarcely less important source of supply is derived from the melting of snow on the Australian Alps, during the spring; the Mitta-Mitta, Little River, Ovens, and Goulburn, together with the principal rivers of Gipps Land, are all considerably affected from this cause, and are subject to sudden and heavy floods from the effects of a few warm days in the spring, suddenly melting the snow on the ranges; although this result is comparatively irrespective of the nature of the formation on which the snow rests. Yet the continuity of the supply from this source will depend, more or less, upon the porous character of the formation on which the snow rests, causing its absorption according as melted, and thus storing it, so as to effect a gradual flow; it is thus that the snow upon the Australian Alps combines with the fissured character of the granitiform rocks on which it is deposited, to produce a greater continuity and uniformity of flow, than if the surface formation were of a more impervious nature.

The Australian Alps, with their extensive spurs, extending far northwards and southwards, under these conditions, and traversing as they do, more than one hundred miles in length in Victoria, thus naturally form the source of an immense supply of water,

which is to a considerable extent stored within their fissures, and given out gradually in the dry season, after the melting of the snow has ceased; this fact is abundantly proved by the measurements of discharge taken by the Survey Department of Victoria in February of the present year; the aggregate discharge southward into Gipps Land, with the exception of the Snowy River, amounted to 1600 cubic feet per second, while that to the northward and westward from the Mitta-Mitta to the Yarra, resulted in 2580 cubic feet per second in December of last year; these results making together 4180 cubic feet taken in the dry season, when the melting of the snow must have ceased, (excepting on the highest altitudes), and thus representing only the residue drainage, would form a combined stream, fully equal to the summer flow of the River Murray below the Goulburn.

With such an amount of water obtainable from this source during the dry season it is reasonable to calculate upon a vastly greater quantity as representing the whole annual flow therefrom, a great proportion of which is carried away upon the sudden melting of the snow, in heavy floods, as is evidenced by the rapid rising of the rivers, frequently up to 18 feet in a few hours, on the first approach of a few warm days in the spring.

It may at least, therefore, be assumed with tolerable certainty, that the Australian Alps, with their connected ranges, occupying an immense area in Gipps Land and the Murray District, form a source of water supply amply sufficient for the whole surface of the colony for all useful purposes.

The practicability of the disposal of a portion of this vast natural supply in the form of central westerly streams, capable of commanding at high levels a large area of Victoria, forms a subject worthy of the deepest consideration, fraught as it is with such importance to the development of all the material resources of the colony; nor should the apparently insurmountable difficulties that present themselves to the execution of such a great work deter searching investigation into its merits. So high an authority as the Surveyor-General has, indeed, already propounded a scheme somewhat similar, and of as great magnitude: in the absence of preliminary surveys, however, it would be premature to decide definitely on the subject.

As the River Yarra forms a sample of the above class of streams, all of which drain from basins similar to its own in

geological character, an examination into the capacity and nature of its basin relatively with the amount of water drained therefrom, will be important in determining the value of such basins generally for the production of permanent streams, and also their capacity for the collection of rain.

This river is contained in a basin of about 1500 square miles, comprised in the southern slopes of the great dividing range on the north, and an extensive spur therefrom on the south and east.

The supply of water is derived principally from two sources:—firstly, rain upon the impervious portions of the basin, comprising the clay-slate, sandstone, and trap formations, which, with the exception of the latter, being generally precipitous, and having little capacity for retaining the rain water falling on them, it flows off, after surface saturation, into the watercourses, the sudden and simultaneous discharge of which into the river causes swellings and floods of more or less magnitude, dependent on the relative amount of rain in a given time and its duration; the other source of supply comes from that area of its basin occupied by the granitic and porphyritic rocks abounding in fissures, and clothed with dense vegetation, and thus having a vast storage capacity for the rain water falling on them, hold back a considerable supply, which is given out gradually by means of a great number of constantly flowing streams of water of great purity.

The geological formations of the basin of the Upper Yarra being as yet unsurveyed, it is impossible to arrive at the relative proportion of the granitic and porphyritic rocks to the clay-slate and others, throughout the whole, which has only been investigated for a distance of forty miles eastward of Melbourne; however, the area of granitic and porphyritic rock, as yet ascertained, amounts to about one hundred square miles, of which the granite at the source of the Plenty alone occupies about ten square miles, and discharges from its fissures in the dry season, when all surface drainage has ceased, about sixteen cubic feet per second, in addition to the discharge on the north side of the range, forming the source of the Sunday Creek.

It is certain, however, that the granitiform rocks do occupy a considerable area in the basin of the Upper Yarra, as it lies mostly on the great dividing range and spurs which consist almost entirely of these rocks, whose presence is further indicated by the number of constantly running streams proceeding therefrom.

The presence of these rocks in the eastern part of the great dividing range, forms an important geological feature, and renders the Yarra, in common with the Goulburn and the rivers of the Murray District and Gipps Land, exceptional to the generality of the streams of the colony, which, for the most part, owe their supply to surface drainage from an impervious watershed, supplemented occasionally by feeble springs. Thus the River Campaspe, below its junction with the Coliban, has a drainage basin of 500 square miles, or about one-third the area of that of the Yarra, and consisting almost wholly of slate, sandstone, and trap formations, having but a limited area of granite, and yet discharged at this point only 4½ cubic feet per second, on the same day that the latter river gave 535 cubic feet. This fact, taken in connection with the ample rainfall on these high basins, forms a striking proof of the immense loss of water due to the absence of porous rocks, and to the generally impervious character of the prevailing formations in the colony, causing the rain either to be returned to the atmosphere by surface evaporation from level ground, or to be rapidly discharged into the watercourses in the form of floods after heavy rain upon steep ground, so that passing off in great volumes, no permanent flow is left more than what may be supplied by casual springs and drainage from swampy flats in the watercourses.

The area of the known clay-slate, sandstone, and trap rocks, in the Yarra basin, occupying nearly two-thirds of the whole, or about 1000 square miles (of which the trap covers one-eighth), is drained mostly by the non-permanent streams; only so much of the permanent ones receive its drainage as pass through it, while they derive their constant flow only from the porous rocks at their source. The discharge of the Yarra in the dry season does not include drainage off this area, its watercourses being then dry, excepting immediately after rain, hence the least or summer flow of the Yarra comes altogether from the remaining third part ot the basin. It is reasonable, therefore, to conclude that the amount of water drained into the Yarra from off the former area of clay-slate, &c., during the year, forms at least two-thirds of that from off the whole basin, especially when the generally impervious and precipitous nature of the surface is considered, which is hence better adapted to collect and rapidly discharge the rainwater off into the creeks than more porous formations.

What the whole mean discharge of the Yarra is cannot be ascertained but by an extended series of observations, but as the least or summer flow is about 535 feet per second or 624,880,000 cubic yards per annum, derived solely from granitiform formations, that from the above distinct area of clay-slate, &c., must, according to the above conclusion, be at least twice this amount, or 1,249,760,000 cubic yards; the sum of these two will give 1,874,640,000 cubic yards as the known least discharge per annum of the Yarra, at Melbourne, as thus estimated.

It is highly important to observe that this amount represents a depth of collected rain water of 14½ inches over the Yarra basin of 1500 square miles, the summer flow alone being equivalent to nearly 4·8 inches depth of rain over the whole basin.

The following facts obtained from basins, analogous and similar to that of the Yarra, tend to confirm the approximate truth of this available collected rain.

The River La Trobe, in the month of February of this year (the driest month), discharged 674 cubic feet per second into Lake Wellington from off a drainage basin of 1900 square miles, equivalent to a depth of rain over the basin of 4·8 inches, being exactly the same as that in the Yarra basin from its summer flow.

The River Mitchell discharged into Lake King the same time (February, 1860) 497 cubic feet per second, its basin being 1800 square miles; this discharge represents a depth of rain thereon of 3¾ inches.

The discharge of the Mitta-Mitta in December, 1859, was 464 cubic feet per second from a basin of 2000 square miles, being equivalent to 3·1 inches of rain.

The Little River, draining from a basin of 700 square miles, next to that of the Mitta-Mitta, discharged into the Murray on the same day 161·8 cubic feet per second, representing a depth of collected rain of 3·1 inches, the same as the Mitta-Mitta adjacent.

The above results taken at periods subsequent to the melting of the snow at the heads of the rivers which were at their summer level, and unaffected by surface drainage, and as such representing but an inferior portion of the whole amount of water passing down annually, indicate a large mean per centage of rainfall as due from the gathering basins of the Murray and Gipps Land districts, which being of a generally hilly character facilitate the discharge of the surface drainage into the watercourses before

being evaporated from the soil, irrespective of that which is held back in the form of snow in the higher regions, and when melted maintains the saturation of the porous rocks forming the source of summer supply.

The collected rainfall of the west half of Victoria lies under more unfavorable conditions than that of the east above. The creeks rising generally in steep clay-slate and sandstone formations through which they traverse for a considerable part of their course, at length emerge upon and flow through vast basalt plains which occupy a large proportionate area of their basins, but contribute little drainage from off their surface; so far as the creeks flow through the upper clay-slate part of their basins they are under the most favorable conditions for obtaining a large per centage of rainfall, and quite on a par with the rivers of Gipps Land and the Murray District, but there being no storage capacity within their basins the great bulk of the water passes rapidly off and is lost for all useful purposes.

The Campaspe, Loddon, and Avoca form examples of this class of streams, which are all non-permanent.

It is yet satisfactory that, notwithstanding the immense amount of rain that is returned to the atmosphere from off the basaltic plains occupying a large area in these basins, that a large per-centage is obtained on the whole due to the superior drainage capacity and extent of the clay-slate areas forming the upper portions of the basins.

Under these circumstances the actual per-centage of rain collected in each basin must necessarily in a great measure depend upon the relative areas therein of the two formations.

But yet another feature tends to the conclusion that the drainage from off the west part of Victoria must be considerably less than that from off the east; the eastern basins being of great altitude and broken character (intersected as they are by the Australian Alps, covered frequently with thick forests and dense vegetation), necessarily attract floating rain clouds, the precipitation of which produces a larger amount of rainfall than that due to more level tracts of country: it is hence not difficult to account for the comparatively arid character of the basalt plains of the western basins, and how, in consequence, the mean rainfall in this part of the colony must be inferior to that towards the east, and, consequently, the amount of collected rain.

In judging of the value of the estimate of the annual amount of collected rain from off the eastern basins (14½ inches), as deduced above from observations on that of the Yarra, it must be borne in mind that such were obtained after two years of known unusual dryness, the amount of rain during which, as observed in Melbourne, was one-third below the average of former years.

It is a more difficult matter to estimate the mean amount of collected rain from off the western half of the colony, there being no legitimate data whatever from which to compute it; it is, however, certain that an amount altogether passes down in the form of floods and otherwise throughout the year more than amply sufficient, and which may be safely set down as at least half of that draining from the eastern basins, or about 7 inches, which is 28 per cent. of the estimated least rainfall of 25 inches; the mean collected rain of the eastern and western basins would thus be over 10½ inches for the whole colony, equal to 680,000 tons of water per square mile.

Taking the mean level of the general surface above the sea at 300 feet, this amount of water would represent a motive power per square mile per annum of 9600 horse-power, which multiplied by the area of the colony, 86,000 square miles, gives 825,000,000 of horse-power for the whole.

STORAGE OF WATER, RESERVOIRS, Etc.

As a great proportion of this water comes down the channels in floods, an immense difficulty is thereby presented to its successful diversion and storage, as the valleys of the streams are generally very deep and precipitous, being frequently from 100 to 150 feet. Under such circumstances, the erection of dams of sufficient strength and durability to resist the action of floods becomes very difficult, especially if there is a large drainage area above them discharging heavy floods;—the formation of a separate channel or bye-wash of sufficient capacity to carry off the floods is also generally impracticable from the confined nature of the valleys, and the necessity of such having a sectional area nearly equal to that of the natural channel.

For these reasons the construction of storage reservoirs in the beds of streams is highly objectionable, excepting where from their large capacity or having a small drainage area, they can

hold all the water, including floods, coming into them, which can seldom be the case but when they are situated on some gently falling flat, near the head of the supplying stream.

It is, however, far down in the course of streams that the most suitable sites present themselves for the formation of reservoirs of large capacity, due to the more level character of the bed, and the extensive flats into which the valleys widen and subsequently contract: in such cases ample room must be obtained for an exit for the overflow by capacious side channels of a sectional area equal to that of the maximum discharge for a given fall.

Under any precautions or circumstances reservoirs formed from the damming up of main streams are liable to danger from the effects of extraordinary rains of three and four inches in a day, which sometimes happen in this colony, and the floods from which could not be conveyed by any artificial bye-channel of a capacity within reasonable limits.

Reservoirs, to be perfectly safe, should be located off the line of drainage that supplies them, as is the case with the Yan Yean Reservoir, which is separated from the River Plenty, supplying it by a low range; the water being conducted into the reservoir by an aqueduct, the supply is thereby capable of being adjusted by a sluice, by means of which only a regulated influx can take place, and irrespective of the floods which pass down their natural channel in the Plenty.

The amount of evaporation from the surface of reservoirs remains yet to be decided. The experiments that have hitherto been made from small vessels of water indicate a mean of about 5 feet per annum, which must be regarded only as an approximation, as the various conditions under which evaporation ensues depending in a great measure upon the influences of climate and physical configuration and temperature render it a question of locality. The anticipations regarding the large amount likely to be lost from the Yan Yean Reservoir from this course having not been fulfilled is only of local value, as the contiguity of the Plenty Ranges shelter the reservoir to a great extent from the effects of hot winds, and preserve a certain amount of moisture in the air surrounding them, so that the hot dry winds blowing from the north and passing over the ranges, must be considerably moistened before reaching the reservoir. Hence it may be inferred that a low rate of evaporation ensues, which should form no guide for

more open and exposed localities. It would be unwise, therefore, in the absence of more extended observations, to base any calculation of evaporation upon less than the mean amount obtained of 5 feet per annum; which, although it may be in excess for districts similar to Gipps Land—of an inferior mean temperature—yet possibly falls short of the reality in many other places, especially upon the basalt plains.

In choosing sites for reservoirs great care should be taken to command at high levels, and supply as large an area as possible. The most remunerative adaptation of storage water must evidently be where it is possible first to take advantage of the height of water in the reservoir, as a motive power for machinery, such as for quartz-crushing; and when that power is spent in the fall, using the same water undeteriorated for ordinary water supply, embracing gold-washing, irrigation, domestic use, &c. Thus, a double duty may be obtained, and the expenditure upon a system of reservoirs throughout the populous districts may be more remunerative. The Yan Yean water, before entering Melbourne, could in this manner be made available for an actual motive power of 800 horses per day, without, in any way, sacrificing the requirements of the city, as there would still be left a head of 150 feet to command the supply of the same water to all the houses. This power would be able to break 1,820,000 cubic yards of road metal in the year (assuming one-horse power for only six cubic yards), at a cost of ¼d. per cubic yard, an amount sufficient for 345 miles of road, laid thirty feet wide, with nine inches of broken stone. This will show the vast importance of designing reservoirs with the double view of motive power and water supply.

If from the peculiarities of climate and geological formation this colony is deficient as regards a permanent supply of water, it is yet singularly favored, in its physical structure, for its economical storage, from its numberless valleys, which permit of economical dams being made across them. The leading gullies through the auriferous districts contain frequent good sites for reservoirs, from their moderate fall and large capacity. In some cases, at the foot of the great dividing range, the creeks rising there pass through deep and occasionally wide valleys, with a fall of about one in two hundred, and where short dams might be constructed that would hold back large bodies of water.

The construction of high dams, so as to obtain a good depth in

the reservoir, is a matter of no small difficulty, by reason of the enormously increasing amount of earth embankment for every increase of height; hence such dams will be most available, where their length is short, in closing up narrow gullies or gaps, such as frequently waterworn through the basalt formation in the line of streams.

In viewing the general suitability of a system of reservoirs to the wants of the colony, it will be necessary to examine closely the limits of their capabilities.

The peculiarly undulating and irregular nature of the basins of the clay-slate and sandstone formations, in which the auriferous districts lie, is unfavorable, in one respect, to the conduction of water by artificial channels, owing to the very circuitous routes they must take, and the consequent expense of conveying water for many miles distance; while, if the natural watercourse be used for this purpose, a great amount of general utility is sacrificed from the low-lying level of the conducted water with regard to adjacent lands. This circumstance tends to confine the utility of storage reservoirs generally to localities forming centres of population; they are hence adapted to supply the wants of the gold-fields: but for the more general purposes of supply to pastoral and agricultural districts thinly inhabited it is to be feared that their adaptation is impracticable within economic limits, excepting in specially favorable localities.

The Yan Yean Reservoir forms a great proof of the possibility of obtaining a large supply of water for storage from very small visible sources. The discharge of the River Plenty, where it supplies the reservoir, was ascertained in the summer of 1855 to be only $6\frac{1}{2}$ cubic feet per second, equal to a yearly supply of eight and a half millions of cubic yards, and capable of occupying only a mean depth of $3\frac{1}{2}$ feet in the reservoir, which is less than the actual evaporation (as assumed from general observations at 5 feet), and forms only one-third of the mean depth of water.

This reservoir is fed from a drainage basin of sixty square miles of a generally steep character, Mount Disappointment forming the northernmost portion, whence the constantly running streams, merging into eastern and western arms, issue, forming a total discharge of about 16 cubic feet per second in the summer time, which amount is lessened by half from absorption and evaporation in reedy swamps before reaching the reservoir. The water near the

source is exceedingly cold and clear, and apparently of great purity, but is subsequently deteriorated in its passage through the swamps. The reservoir itself is about eight miles from the sources, and lies off the Plenty; it occupies an area of 1440 acres, and is capable of containing 25,000,000 cubic yards of water; the annual evaporation, reckoned at 5 feet in depth, is 11½ millions cubic yards, or nearly half its whole capacity. Assuming the total available supply to be only 22,000,000 cubic yards, as estimated in the year 1855, the water of the reservoir would have a motive power of 2½ horses per foot of fall, which, multiplied by the approximate height above Melbourne, or 600 feet, would result in a total theoretical water power of 1500 horses, 80 per cent. of which, or 1200 horses, can be made available by means of the Turbine or horizontal water wheel, the useful effect of which has been proved up to that percentage.

This immense power being available from the reservoir is necessarily due to the water being conveyed under pressure to Melbourne, 600 feet lower, and at a very large cost, which it was considered the special object in view warranted; but such an example will not serve to illustrate the results to be expected from reservoirs in general, which it will be practically impossible to construct so as to obtain a great head of water by conveying it in pipes, the enormous expense of which and cost of carriage will preclude their use, excepting in special cases where a very sudden fall will permit a short length of pipe being laid. In any general system of reservoirs, therefore, the motive power will be probably limited to such head of water as will be due to the height of the embankment up to the water level.

The natural reservoirs of Victoria, comprising principally the lakes and lagoons of the counties of Hampden, Heytesbury, Grenville, and Polwarth, form no mean feature in its varied resources, and are in many instances capable of being turned to profitable purposes. The county of Hampden contains 47 square miles of lakes and lagoons, of which 16 square miles are fresh, 19 brackish or slightly so, and 12 salt. Grenville has Lakes Corangamite and Murdeduke, both salt, and occupying together an area of about 80 square miles, together with a number of smaller lakes covering an area of about 10 square miles, and which are either mostly salt or brackish. The county of Polwarth contains the magnificent fresh water lake Colac, which has an area of 9 square miles.

Lake Corangamite forms the centre of a group consisting of many of the above, and its site represents the lowest part of a general depression of the surrounding district, which consists of basalt plains. The origin of this vast system of lakes is probably due to the sudden cooling and consequent arrest of the molten flood of lava which, flowing down from all sides over an original depression or basin forming an inlet from the sea surrounded and drove before it large isolated bodies of sea water, which, having thus no means of escape, their area was constantly diminished, while their depth increased till they overflowed the encroaching lava and attained in their thus concentrated volume an immense cooling power which, in conjunction with their ncreased hydrostatic pressure, arrested the further advance of the lava.

Viewing the origin of the lakes according to this theory, it would not be difficult to account for the presence of salt in them; the immense vaporization that would be caused by the molten flood would necessitate a deposition of salt throughout the pores and fissures of the lava or basalt, and quite sufficient to account for the saline springs emitted therefrom.

That the saltness of the lakes is due wholly to the accumulation of salt in solution passed into them by drainage from out of the basalt rock, and not to any inherent saline matter, will be borne out by a minute inspection of the counties of Hampden, Grenville, and Polwarth. It will be observed that the salt lakes, such as Corangamite and Gnarpurt drain their supply from creeks passing through basalt in addition to such springs as may issue from their banks, while the merely brackish have generally no channels flowing into them, and consequently have a diminished saline supply confined to springs. Again the fresh lakes of which Colac forms the type, have, in most cases, no watercourses discharging into them from off the basalt, excepting when they have an outfall, but are supplied by surface rain and creeks draining through other formations. Thus Colac, which is fresh, is supplied by the Birregurra Creek, draining a sandstone basin.

It may be observed that the Corangamite and adjacent lakes and lagoons have no outlet, hence the water in them is the residue left after evaporation from their surfaces. Under these circumstances, all the salt delivered into them in solution from creeks and springs in their banks from year to year, remains therein and con-

stantly accumulates, while the amount of water remains approximately the same, and thus contains a constantly increasing per-centage of salt. These facts tend forcibly to the conclusion that at a certain era immediately subsequent to the deposition of the basalt and the formation of the lakes, there existed no appreciable saline matter in their wateis, for if the accumulation of salt in them during untold ages has been only sufficient to render many of them brackish and others salt, instead of producing salt beds, it will be presumed that the mean annual per-centage of salt delivered into them from their earliest formation must be inappreciable.

These presumptions are strengthened by the fact that the salt springs in the basalt are generally very feeble, and when mixed with the great body of fresh water surface drainage before flowing into the lakes are insufficient to affect it sensibly.

It may be inferred, therefore, that it is only the accumulation of salt in the lakes during a long period that renders its presence perceptible, and not the inappreciable amount received yearly.

Were it, therefore, possible to drain the salt lakes of their present contents, and thus remove their saline accumulations (presuming in each case the whole of the salt is in solution), it may reasonably be inferred that they would be converted into reservoirs of fresh water, as the yearly amount of salt then received by them would be so inconsiderable as to take long periods analogous to the past to restore them to their present saline condition.

Lake Boloke presents strong presumptive evidence for the soundness of this inference, being fed by the Fiery Creek passing through a vast extent of basalt country emitting salt springs; its water is, nevertheless, fresh, owing to its having an outfall in the salt creek, which thus carrying off the salt in solution prevents its accumulation.

It may thus be seen with what harmless results a lake may receive its supply from off a basin having salt springs provided it has an outfall.

Lake Purrumbeet, which is fresh, and receives its supply from the basaltic stony rises, forms additional testimony to the above conclusions, it having an outfall in Curdie's Creek, of which it forms the source.

Again, Lake Hindmarsh receives the whole drainage of the

Wimmera River, is fresh, and discharges by means of an outlet into Lake Albacutya, twelve miles lower down, which is salt, and forms the virtual termination of the Wimmera drainage, although there is a dry outlet from it, but which has not flowed for many years. In this case the whole of the salt in Albacutya must have passed originally through Lake Hindmarsh, but in such constant minute quantities as not to affect its water, while the concentration of the same for want of further outfall produced the saltness of Albacutya; it is thus easy to understand how a fresh-water stream, having but an inappreciable amount of salt, may terminate in a bitter salt lake.

Lake Burrumbeet, situated in a basalt basin, and having an outlet in Baillie's Creek, adds additional testimony to the efficacy of an outfall in preserving fresh water in lakes fed partly from saline sources.

Presuming upon the validity of the above conclusions regarding the cause of the presence of salt in the lakes as due to accumulation, and not to any inherent saline character, it becomes a question of great practical importance to determine the possibility of withdrawing the saline matter from the lakes by drainage, and thus restore them to their ancient state of natural fresh water reservoirs.

Lake Corangamite, as before stated, forms the centre of a gentle depression, in which are situated nearly all the lakes and lagoons eastward of the Emu Creek, in the county of Hampden. Mr. Scott, the district surveyor, states in corroboration, that the whole lake country, north of Mount Leura, drains into it. It is, hence, practicable to connect this system of lakes by open channels, and thence drain them into Lake Corangamite. One channel, about twelve miles long, can intersect the principal group of lakes, inclusive of Bookar, Timboon, Weeranganuck, &c. Lake Gnarpurt is only separated from it by a narrow neck of land, while most of the remaining lakes are within a mile of its western shore; considering the level nature of the ground, being a basaltic plain falling towards Corangamite, no difficulty is presented to draining nearly all the lakes into it from its western basin.

To discharge this connected body of water eastward into the Barwon would effect the desired end, and to which the slight depression of the east basin of Corangamite presents but little difficulty. A channel, commencing from the north-east corner of

Corangamite, and passing easterly through the centre of Lake Murdeduke to the Barwon, would involve but little deep cutting, as the highest point of the land dividing the basin of Corangamite from that of the Barwon cannot be more than a few feet above the lake, as the Lake Colac overflow, which drains northerly down to this point for a distance of about eight miles, is only ten feet above Corangamite, and if from this be deducted the amount of fall for eight miles, it is probable that three or four feet will be the greatest height of the land above Corangamite. This highest point lies about eight miles east of the lake, and as it would be necessary to make the channel deep enough to drain the lake to its general greatest depth, which is about ten feet, the probable depth of cutting at this highest point would be about fifteen feet, while for the largest part of the distance eastward on the fall to the Barwon, a mere surface channel about three feet deep would be sufficient, as the current of water would soon increase its sectional area either in depth or width, having, as it would, a good fall to the Barwon. The mean depth of cutting would thus be nine feet, and taking a width of three feet as sufficient to open the channel, (side slopes being unnecessary, owing to the falling banks being washed down by the current,) the amount of cutting required for the whole distance from Lake Corangamite to the Barwon (twenty-six miles) would be 137,280 cubic yards; and, assuming the possibility of some of the deeper cutting being through basalt rock, an average cost of 5s. would entail a total expenditure of £34,320 for draining off the present salt water of Corangamite into the Barwon. If to this be added twenty miles of open drain, of an average depth of three feet and same width, for connecting Corangamite with the western lakes, so as to receive their drainage, the amount of cutting would be 35,200 cubic yards, which, assuming it all earth, if estimated at 3s. per cubic yard, would come to £5280. Thus the total cost of discharging Corangamite and adjacent lakes into the Barwon would be £40,000 nearly.

The channel thus formed would be capable of draining at a very trifling further expense the large group of salt and brackish lakes which lie in a direct north line from Lake Colac, and form the course of its overflow: also, in passing through Lake Murdeduke (which has an area of seven square miles, and is salt), would carry off its water.

As the discharge of this salt water from the lakes would be

only temporary until their salt was carried off, no valid objection can arise to its delivery into the Barwon, whence it would soon pass rapidly to the sea.

Presuming upon the practicability of the above scheme, the great advantages attained thereby are apparent. Corangamite, 18 miles long and 4 miles wide, together with its neighbour Lake Gnarpurt or Little Corangamite will present a fresh water surface of upwards of 80 square miles, irrespective of that comprised in the numerous adjacent lakes; and as the mean depth will be about 5 feet, the reservoir capacity will hold 413,000,000 cubic yards of fresh water, or nineteen times more than the Yan Yean Reservoir; the outfall channel to the Barwon also will render the water available for 26 miles of country for irrigation and general purposes.

Were local utility the only question involved, the above scheme would be the most economical and practical; but if, in addition, general reproductive results be looked for from such immense resources, a different and more costly mode of developing them should be adopted, by means of which the motive power of this vast body of water, situated at a height of 346 feet above the sea, might be made available, and irrigation and general water supply be obtained on a grand scale to command a large tract of country.

With this view an outfall channel might be cut from Lake Corangamite eastward till it reached by a nearly uniform fall the nearest point to Geelong, on the Ballaarat railway, that is, 200 feet above the sea, which is probably about 8 miles therefrom, near Batesford; thence a pipe in continuation should be laid along the railway to Geelong, conveying the water under pressure due to the 200 feet of head.

The fall of the channel would be 146 feet in its whole distance of about 40 miles, or more than 3½ feet per mile; with an excavated sectional capacity of 4 feet mean depth and 3 feet wide, the water passing down would have a velocity of about 28 inches per second, with which it would so abraid the sides and bottom of the channel as to gradually increase its sectional area until it was sufficient for the discharge, which will comprise, in addition to that supplied from the lakes, the drainage off 150 square miles of the plains lying between the Rivers Woady Yaloak and Leigh, also the water of the River Leigh, Warrambine, Native Hut, and Bruce's Creeks, all draining from the north; by making the channel wholly in excavation, instead of depending partly upon

a made side bank, there can be no doubt but that this vast drainage can be made to wear away an ample capacity in the channel for their discharge, excepting the heavy floods.

Although Lake Corangamite, including Lake Gnarpurt, is estimated to contain 413,000,000 cubic yards, yet this amount cannot be regarded as a yearly supply available, as it is only a certain constant quantity remaining after all evaporation, but not cumulative; the evaporation however over the 80 square miles of lake surface which is now lost, taken at the generally assumed rate of five feet, would amount to 413,000,000 cubic yards, the same as the estimated capacity: it is from the saving of this that a constant supply can be depended on. Corangamite, in common with nearly all the lakes of the colony, has a very gently sloping bed, whose section would be approximately represented by a triangle with the apex at the deepest point; hence if the constant supply abstracted from the lake was such as to reduce its extreme depth by half, the quantity so obtained would be three-fourths of the whole, while the surface of evaporation would be reduced three-fourths, and hence the amount evaporated; this latter amount thus saved would exactly balance that abstracted for useful purposes, inasmuch as the whole annual evaporation taken at five feet is equal in amount to the contents of the two lakes whose mean depth is also five feet.

For the same reason if Corangamite was constantly drained to its full depth the whole yearly evaporation would be saved which would represent the amount yearly drained off. It is hence clear that whatever depth of water be drained out of the lake it will be balanced by the saving in the amount of evaporation consequent upon the reduced area exposed thereto.

The total amount of water available therefore from Corangamite and Gnarpurt for all useful purposes will be that evaporated, or 413,000,000 cubic yards per annum.

This amount of water conveyed by the channel to the locality above mentioned, 200 feet above the level of the sea, would represent a constant daily theoretical motive power of 8000 horses, or about 6400 effective.

The excavation for the channel, 40 miles long, would be 93,000 cubic yards, taking the cost of which as high as 5s. (in order to cover possible contingencies of occasional rock cutting) the whole cost would be £23,250, to which should be added £10,000 for

five dams laid in masonry for carrying it across the beds of the watercourses it intersects, making the total £33,250.

The pipe conveying the water in continuation to Geelong would probably be eight miles laid along the Geelong and Ballaarat railway, which offers peculiar facilities for its economical transit and fixing; taking it of the same diameter as that laid for the Yan Yean Reservoir, or 33 inches, it would weigh altogether 6720 tons, and, assuming its cost per ton laid at £15, the whole length of eight miles would cost £101,000. This pipe, with its head of 200 feet, would discharge water with a velocity of 3·52 feet per second, which multiplied by the sectional area will result in 21 cubic feet per second as the discharging capability of the pipe, which is equivalent to 50,600 tons daily falling 200 feet and forming a constant theoretical motive power of 477 horses.

This forms only about one-seventeenth of the whole power; for every additional 477 horses power a separate pipe would be required, involving in each case a similar expenditure, and which might be added according as the increase of manufacturing and industrial pursuits demanded.

The amount of water delivered by a single line of pipe (as above) would form an allowance of 226 gallons per head per day for a population of 50,000 persons at Geelong.

Apart from motive power and water supply, the water available from Corangamite (as above set down) would be sufficient to irrigate for a depth of 30 inches, per annum, 160 square miles of the plain country along the south side of the channel, which latter would be admirably adapted for distributing the water along its whole course of forty miles.

The amount of water available from Corangamite is so large, and evidently far in excess of all possible requirements of motive power, water supply, and irrigation, that a small proportion of its depth need only be drained out, leaving ample water behind still to present the appearance of a magnificent lake, as one-fifth of the whole depth drained off would equal three times the contents of the Yan Yean Reservoir, and would only reduce the level of the water one foot.

Viewing the various beneficial objects attained in this scheme, comprising the conversion of Lakes Corangamite and Gnarpurt into fresh water reservoirs, whereby the unsold land all round would have an enhanced value, irrigation on an extensive scale—motive

power and water supply to Geelong, capable of unlimited extension—it must be apparent that the required expenditure (£134,250) upon the necessary works would be highly reproductive, and of incalculable importance to the industrial development of the localities concerned.

Lake Colac is the finest body of fresh water in Victoria, having a drainage basin of 75 square miles area, situated mostly in a hilly sandstone formation. The proportion of drainage into it must be considerably greater than that into Corangamite. Its area is about eight square miles, one-tenth that of Corangamite and Gnarpurt combined, situated at a level of 354 feet above the sea, and having an overflow northward and eastward to the Barwon it commands 300 square miles of the plains between Corangamite and the Barwon, and is consequently admirably adapted for irrigation and general water supply over this tract. The whole amount of water available, as measured by the amount of evaporation taken at 5 feet in depth over the surface, would be 41,000,000 cubic yards, which might be largely supplemented by catchwater drains cut throughout its basin, and probably also by draining the head waters of the Barwon above Buntingdale into the Birregurra Creek that supplies it. The large area of land that this lake commands, and that could be considerably enhanced in value by the distribution of its waters by surface channels, warrants a liberal expenditure for increasing its source of supply to the utmost.

Burrambeet ranks scarcely inferior to Colac as a fresh water lake, having about the same area (8 square miles). It is supplied principally by the Burrambeet Creek, rising in the great dividing range, on the south side of which its basin is situated. This lake could be converted into a very capacious reservoir, by damming up its outfall at the head of Baillie's Creek, and by increasing its drainage area, by a catchwater drain from the Emu Creek at Mount Ross, ten miles in length, to its western shore, by means of which the Trewalla and heads of the Emu and Springhill Creeks would be cut off, and the area of drainage trebled and increased to about 200 square miles. This drain, 3 feet wide and same depth, at 1s. 6d. per cubic yard, would cost £1320, inclusive of two small dams across the creeks. An embankment at the outfall of Burrambeet 15 feet high, and which would not exceed one quarter of a mile in length, would contain 22,000

cubic yards, which, at 5s., would cost £5500: the total cost would, therefore, be £6820.

The amount of water stored by this embankment (excluding the present contents) up to within three feet of its top, would be 99,000,000 cubic yards, or about four times the capacity of the Yan Yean Reservoir, which would not be sensibly lessened by increased evaporation, as the present area of the lake would not be enlarged, owing to the defined banks.

This large body of water spread over the additional drainage area, would represent a depth of collected rain over it of 9 inches, which considering the nature of the gathering ground being at the foot of the dividing range, is an amount to be depended on.

This reservoir would command an immense extent of plain country, in the counties of Ripon and Hampden, including also the auriferous country of Carngham; it could also be led by a partly tunnelled channel into the northern auriferous district of the county of Grenville, from whence it would command many hundred square miles of auriferous country; considering the very small cost of so large a reservoir, and also its extensive capabilities, its realization would be very remunerative.

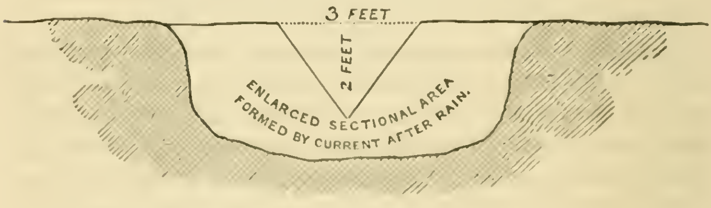
SUPPLY OF WATER TO THE PLAINS.

Storage reservoirs are manifestly unsuited upon the level plain districts, of which there is such a large extent in Victoria, especially to the north; from their unbroken character they have a diminished rainfall, and high rate of evaporation, and hence frequently present a dried up appearance in the summer time; the water courses are few and far apart, and receive a very small amount of drainage, from the level nature of the ground, and that only from their own vicinity; the soil being frequently of a retentive character, the rainfall rests upon the surface, till restored to the atmosphere by evaporation, and when porous absorbs the rain to considerable depth, as in the Wimmera District; in either case the rainfall is almost wholly lost, and its collection for storage unavailable.

An examination of the map of Victoria, will shew that upon the plains generally, there are very few main watercourses, and these frequently with an interval between them of twenty miles and upwards, while there is an almost total absence of tributary

creeks; the Goulburn, Campaspe, Loddon, and Avoca, where flowing through the plain country, form examples of this, while the steep higher country, nearer the great dividing range, is comparatively well drained by numerous creeks; these facts evidence the relative capacity of level and steep country for drainage of their surfaces; the plains from want of sufficient slope, have little power to discharge their surface water, and hence the paucity of their watercourses, nevertheless, a vast amount of water passes down through the plains from the higher country, in the form of floods, which might be made available for them. The River Loddon inundates an area of plain along its course for five or six miles on each side, the diversion of which, and subsequent distribution by various artificial channels, would render it available for water supply and irrigation, to a large tract of flat country; the Campaspe also delivers a very large body of water in the form of floods, which all could be turned upon the adjacent plains, for many miles on each side.

It is proposed by the author to divert the flood-water coming from the higher grounds upon the plains by means of small artificial channels of a triangular section, 3 feet wide and 2 feet deep (as shewn on the annexed sketch), led from natural lines



of drainage dammed up, which shall traverse the plains in the general direction of their fall, but in a zig-zag course (so as to increase their frontage and usefulness), and be further fed by similarly formed branch catchwater drains, parallel with the nearest natural watercourses, whereby it is expected that the main centre channels thus cut economically with small sectional area, will be further enlarged by the scouring action of the body of water led suddenly into them, until they are converted into sufficiently capacious watercourses, self-excavated. Many such water-formed creeks exist in this colony, and are being formed constantly on land stripped of its soil and along wheel tracks,

a sufficient velocity in the running water being the only requisite, which on the plains will be attained by a large body of water passing down suddenly.

The plains thus intersected with main and branch drains thus formed, can be made to discharge a considerable amount of their surface water into them by means of a number of sub-catch drains, cut by the plough and enlarged by the current of water through them after heavy rain.

With such a system of artificial watercourses thus economically formed, a great amount of surface water which would be otherwise evaporated may be collected even after average rain, and thus may a vast extent of flat country in Victoria be rendered available for agricultural settlement which is now almost devoid of water or watercourses.

These main channels, when enlarged sufficiently by the current, from their still small sectional area and their comparatively low rate of fall, will hence be capable of being dammed up wherever required by settlers or farmers, and at a very trifling expense; and thus may form a series of elongated waterholes, periodically fed from floods and surface drainage, irrespective of which they will act as main water conduits, from which while flowing supplies can be drained to fill excavated tanks at various distances on each side.

This general system of artificial watercourses has the advantage of conveying water throughout a great frontage for settlement, and which is available for private storage, at the expense of parties requiring it. Thus the cost of public storage reservoirs is avoided, while that of the water channels is inconsiderable, from their being mostly self-formed.

Facilities for irrigation will also be obtained by these channels, the temporary damming up of which, at any desired point, will turn the water while flowing over the adjacent fall of the land, wherever its direction forms an angle with that of the channel, which latter should, as a general rule, be laid out in a zig-zag form, at a general angle of 45° with the line of fall, not only to permit of irrigating land on the lower side, but also to form a catch for receiving drainage on the upper side. Irrigation will also be promoted after heavy floods, by the overflow of the channels on the land below them, the residue drainage of which will flow back, by means of the sub-catch drains into the main

channels lower down; it is hence important that they should have a devious course.

The open plains lying between the Rivers Avoca and Campaspe, comprising an area of about 3000 square miles, could thus be supplied with water from the floods of these rivers and the Loddon, and from the Bendigo and Myer's Creek falling to the north.

The floods thus turned upon this large tract would come off a steep drainage basin of about 4000 square miles, one inch rainfall upon the whole of which in one day would certainly be sufficient to irrigate the plains three-quarter inch deep, and supply storage water enough besides to fill all the tanks and dams that could possibly be required in the district. It is, however, most unlikely that such a rain would occur over the whole basin at the same time, although one inch and upwards may be of frequent occurrence in one part of the basin, while at the same time there is no rain in other parts; but this circumstance is highly favorable, as thereby the delivery of water is moderated and spread over a greater period, producing correspondingly longer beneficial effects.

It may be objected that the water stored in the tanks, &c., will be in a great measure lost by evaporation, but such can be almost wholly counteracted by making them narrow and long, so as to permit of their being covered over by logs and brushwood, which will protect the water from sun and wind.

It may also happen that in some parts of these plains the surface may be of too absorbent a nature to hold water, but the existence of Lakes Leaghur, Meering, Boort, and the Boga lakes further north, although some of them are dry in summer from evaporation, tend to a different conclusion.

Apart from the question of obtaining water supply by various means as above, the diversion of the fine permanent streams proceeding from the Australian Alps, presents splendid facilities for the improvement of large tracts of country, by constant irrigation throughout the year.

Mr. Dawson, the district surveyor, reports that the rich central plains of Gipps Land that are watered by the Rivers La Trobe, Thomson, and McAllister could be irrigated at a very trifling expense by water led from the base of the mountains, and that the value of the land would be thereby increased from three to four fold.

The Little River flowing northerly from the Bogong Ranges into the Murray, into which its least or summer flow is about 160 cubic feet per second, is available by diversion for irrigation, and for supplying water to the Yackandandah gold-fields.

The Ovens River discharging about 600 cubic feet per second in the summer time (which is more than the Yarra), at Wangaratta, is well suited for irrigation and water supply to the large tract of country between it and the Murray; likewise the King River, a tributary of the Ovens, and having a summer flow of 150 cubic feet per second is similarly available for its adjacent lands.

The River Goulburn could easily be diverted at Seymour so as to supply the gold-fields of the county of Rodney and irrigate the large tract between them and the Murray, embracing altogether nearly 1000 square miles. A cutting, thirty miles long, from Seymour to the gold-fields, six feet wide and same depth, with a triangular section which would be considerably enlarged by the action of the current, would involve 105,000 cubic yards of excavation, which, at 5s. to cover occasional rock cutting, would come to £26,000; from the gold-fields the water could be conducted all over the country towards the Murray by inexpensive open cuts, which would be enlarged by the action of the current; this desirable scheme would be of vast importance to these extensive gold-fields which are almost undeveloped for want of water. The Goulburn discharge at Seymour last summer was about 800 cubic feet per second, so that a stream as large as the Yarra could be turned over the county of Rodney throughout the year, if necessary.

There can be no doubt that were the plains of Victoria well watered, wherever practicable, from the higher lands, and their surface drainage increased by a judicious and economical system of catch-water drains, by means of which still lower levels might be supplied, the results would be of a most beneficial nature both to pastoral and agricultural interests, and the production of food would be considerably increased while its cost would be economized. Certain evidence exists that for most localities an ample quantity of water is obtainable, but its judicious application for each place must regulate reproductive results.

ARTESIAN WELLS.

The question of the adoption of artesian wells as a means of water supply is one fraught with much difficulty, owing partly to the limited information regarding the geological character of some districts and the small evidence regarding the extensive existence of secondary formations, and of vast tertiary beds so necessary to the absorption and storage of water within them.

The clay-slate and sandstone formations which have been upheaved by plutonic rocks, occupy a large area in the colony, of a very undulating character, and dip considerably below the general surface where they are overlaid with immense plains of basalt, or with shallow beds of gravel and sand, frequently covered with recent basalt. It is possible that water may percolate through the surface formations, and be conveyed over the clay-slate, or sandstone floor beneath to lower levels at great depths below the surface, especially where tertiary beds intervene between the surface basalt, but hitherto the only evidence obtained is from the water-worn valleys through the basalt plains of 150 feet deep, which frequently denuded down to the underlying slate-rock, indicate only by occasional feeble springs the presence of water, which is generally either salt or brackish. It would, however, be premature, in the absence of the results of borings to much greater depths, to arrive at definite conclusions regarding the water-bearing qualities of the basalt and underlying formations.

Those strata from which the most hopeful results can be expected are evidently those alluvial beds of sand and gravel which are in the leading valleys of the auriferous districts, and extend to very considerable depths, covering the sites of ancient watercourses, and offering many difficulties to mining operations.

It is not improbable, however, that the plains in the Murray basin may contain tertiary beds of great thickness, in which an abundant supply of water could be obtained. Wells on the Murray plains, on the New South Wales side, have been sunk through clay and marl till sand was reached, but in every case either salt or brackish water was found; what the results would be were the sinkings carried to considerable depths, is yet to be ascertained.

Towards the west of the colony, on the Glenelg, an extensive

limestone formation exists, overlying sandstone, and extending from the coast northward to the Murray, where it appears on the river banks.

This rock probably extends throughout a considerable portion of the dry Wimmera District, and would very likely afford large supplies of water by means of artesian wells, as the rain upon the surface of this district, which is very flat and sandy, is almost altogether absorbed within the ground, and probably percolates through porous beds of sandy clays, gravel, and sand, down to the limestone beneath.

Various places along the sea coast, of similar formation, would probably be available for artesian wells.

The enquiry into this important branch of the subject of water-supply requires more definite determination of the nature, area, and localities of the secondary and tertiary formations, without which no conclusive results can be arrived at.

CONCLUDING REMARKS.

In the supply of water to the gold-fields of this colony is embraced its material progress, as, indeed, it may now be assumed that the richness of a gold-field is as much identical with its water supply as with its auriferous wealth; any scheme, therefore, that will effect the constant supply to the auriferous districts at an economical rate, will certainly raise the production of gold considerably. Storage of water by reservoirs must necessarily be limited to localities, and hence they are restricted in their usefulness. A general scheme is required by which a great area of the colony can be commanded at high levels, to effect which economically and within reproductive limits, is the great problem. The Australian Alps, as above stated, form a great natural storage reservoir, from which an aggregate flow equal to the Murray in summer, drains off in the driest time of the year; to divert a portion of this immense supply westerly along the north side of the dividing range would effect all that could be required. From this source an ample supply would be available, which would command all the northern auriferous districts; the absence of surveys, however, prevent definite conclusion on the merits of this scheme.

It has been attempted in this treatise to demonstrate that although the surface of this colony generally is unfavorable to

the generation of permanent streams, yet that an ample supply of water exists requiring only the judicious expenditure of capital to render it available economically; the conclusions generally come to are based upon facts regarding the watercourses of the colony obtained by the Survey Department, which, although so far as the summer flow generally is concerned, cannot be considered on the whole satisfactory; bearing in mind the large drainage areas of the various streams, it is, nevertheless, certain that an ample amount of water is delivered into them throughout the year, which, if conserved by an economic system of storage, would be invaluable for agricultural, pastoral, and mining purposes. In order to ascertain the capacity of the valleys of the various watercourses for the storage of water at such levels as will command a large extent of country beneath them, and will permit of the construction of aqueducts leading to centres of population, where required, it will be necessary to obtain such sections as will indicate the relative heights above the sea of the beds of the various watercourses, at frequent intervals. Were such levels carried out from the coast as a base northwards up the valley lines to the dividing range on one side, and from the Murray River southwards up its tributaries to the north side of the dividing range, a network of relative levels would be established of incalculable importance to all schemes for increasing the water supply, as also to general engineering and scientific purposes.

FREDERICK ACHESON, C.E.

30*th September*, 1860.

APPENDIX.

Table of Discharges and other particulars of the Rivers and Creeks of Victoria, deduced from observations obtained by the Survey Department.

Rivers and Creeks North of the Great Dividing Range.

Date of Observation, 21*st December*, 1859.

River or Creek.	Locality.	Sectional Area in square feet.	Mean Velocity per second in feet.	Discharge per second in cubic feet.
Mitta-Mitta River.	Near junction with Murray	241·84	1·92	464·3328
Little River.........	Above junction with Murray	114·000	1·42	161·88
Ovens River........	At Wangaratta......	861·000	·693	596·67
King River	At Wangaratta......	140·7	1·09	153·3
Broken River	At Benalla...........	...	...	0·0

REMARKS.

Mitta-Mitta River.—Rises in the Australian Alps, and derives a large portion of its waters from the melting of snow on ranges at sources during the months of September, October, and November, being period of highest flood. Basin, 2000 square miles; length, 100 miles.

Little River.—Rises in the Bogong Ranges. Suitable for irrigation and supply of water to Yackandandah gold-fields; receives a great portion of its waters from the melting of snow on ranges at source, especially Bogong.

Ovens River.—Rises in the Great Dividing Range. Could be made available for navigation for 30 miles from the Murray, by removal of dead trees; available for water supply to adjacent country, and irrigation. Source in Dividing Range, between Murray district and Gipps Land. Approximate length, 100 miles.

King River.—Rises in Mount Buller. Applicable for water supply to neighborhood and irrigation. Approximate length, 50 miles.

Broken River.—Rises in the ranges near Mount Buller. Principal tributary Halland's Creek ; but slightly affected by snow ; applicable to watering the tract of country between it and the Murray.

RIVERS AND CREEKS NORTH OF GREAT DIVIDING RANGE—*continued.*

River or Creek.	Locality.	Sectional Area in square feet.	Mean Velocity per second in feet.	Discharge per second in cubic feet.
Goulburn River ...	Above junction with the Murray	1064·62	1.462	1556·004
Campaspe River (1)	At Kyneton	0·0538	0·475	0·0255
Campaspe River (2)	A short distance above junction with Coliban	1·68	0·223	0·375
Campaspe River ..	Immediately above junction with Coliban	6·9	0·070	0·481
Campaspe River (3)	Immediately below junction with Coliban	39·34	·115	4·524
Campaspe River...	At Echuca, its termination	211·8	0·00	0·00
Coliban River (1)	At Malmsbury	27·0	0·27	7·29

REMARKS.

Goulburn River.—Rises in the Great Dividing Range. Is considerably affected by the melting of snow at the sources. All the tributaries above Sunday Creek permanent all the year, with only one or two trivial exceptions. Can be made navigable up to Seymour at a moderate outlay. The water is very fine and clear. Basin, 6700 square miles; length, 200 miles.

Campaspe River—(1) Rises in the Great Dividing Ranges, to the east of Coliban, and flows over a slate country as far as the Five Mile Creek, and thence to Kyneton over trap with but few springs. The floods rise rapidly, owing to the steep watershed on the north side of ranges. Not permanent; consists of a series of water-holes during summer all through its course.

(2) Eight hundred feet above the sea; difference between summer level and greatest floods about eight feet.

(3) Same remarks above apply. This is the combined discharge of the Coliban and Campaspe at their junction; at this place an extensive storage reservoir might be formed.

Coliban River.—(1) Source at the Great Dividing Range, and runs northerly, receiving as tributaries the Little Coliban and the Kangaroo Creek above Malmsbury, both of which are supplied by springs of good quality, rising in a high country of trap rock, and except in extraordinary seasons of drought flow throughout the year. This constant supply affords great facilities for supplying the gold fields, Castlemaine and Bendigo. The watershed of Coliban, above Taradale, is 160 square miles, and well adapted for irrigation. The Tea Tree Creek is another tributary, about a quarter of a mile above the section at Taradale, and although it has a small watershed, it affords a never failing spring of good water.

RIVERS AND CREEKS NORTH OF GREAT DIVIDING RANGE—*continued.*

River or Creek.	Locality.	Sectional Area in square feet.	Mean Velocity per second in feet.	Discharge per second in cubic feet.
Coliban River (2)	At Taradale	6·6990	1·0	6·6990
Coliban River (2)	Immediately above its confluence with the Campaspe	8·107	0.3762	3·050
Loddon River (1)	Two and a half miles above junction of Fryer's Creek	5·2	0·0996	0·518
Loddon River (2)	At Newstead.........	2·06	0·666	1·3719

REMARKS.

(2) From Taradale to the junction with Campaspe River (25 miles) are the largest tributaries, namely, the Back Creek, near Taradale, Jennings Creek, and Myrtle or Cockatoo Creek, (this latter rises in the Mount Alexander Ranges,) all of which join the Coliban on its west bank; they cease to flow in dry weather. About eight miles below Taradale the Coliban forms itself into a chain of water-holes, some of considerable size, and apparently ceases to flow, at least its flow decreases from Malmsbury to the junction, probably owing to evaporation or absorption by the soil. There are three falls on this river—one 15 miles above Malmsbury of 86 feet, one small fall between Malmsbury and Taradale, and the other (the "Coban" of Sir F. Mitchell) about 11 miles below Taradale; the two first flow over trap, the latter over granite. Bed of Coliban at Malmsbury over low water at Hobson's Bay, 1417 feet; at Taradale, 1215 feet.

Loddon River.—(1) The river up to this point is fed by rainfall and is destitute of springs. except a few in the trap country. Is fed by a number of small creeks extending back from half a mile to ten miles. Owing to the precipitous nature of the basin, the water-level is subject to rapid fluctuations, rising in a few hours, after heavy rains, to a great height, and subsiding in a few days. At the present time it is merely a chain of water-holes connected by small rills, discharging only ·518 cubic feet per second. The valley of the river is well adapted for storage reservoirs, being hemmed in on both sides by hills ranging from 150 to 200 feet high, which fall back from the river in places and again approach close up, overhanging its banks in frequently a precipitous manner, thus forming a number of natural bays which might easily be converted into extensive reservoirs for water supply and motive power, at small cost when compared with the results obtained.

(2) Surface of country draining into river impervious and precipitous, so that water is carried off rapidly. Present state of river a chain of water-holes, which might be dammed up and would contain a moderate supply of water. River does not flow for some time in summer.

RIVERS AND CREEKS NORTH OF GREAT DIVIDING RANGE—*continued.*

River or Creek.	Locality.	Sectional Area in square feet.	Mean Velocity per second in feet.	Discharge per second in cubic feet.
Loddon River (3)	At Newbridge	0·150	1·000	0·150
Loddon River	At the junction of the Serpentine Creek	0·969	1·50	1·453
Avoca River	...	...	...	0·00
Avon River	...	...	...	0·00
Wimmera River ...	...	...	...	0·00

REMARKS.

(3) The Loddon is supplied by drainage from a basin of 4800 square miles and receives seven tributaries on its east and north banks, and eleven on its south and west banks, none of which are permanent but form in summer a series of water-holes, being almost entirely supplied by surface drainage from off clay-slate, sandstone and trap watersheds.

Avoca River.—Rises in the Amphitheatre Ranges and proceeds northerly about 110 miles to within 16 miles of the Murray, where it falls into Lake Bael Bael, which has no outlet. It only runs during the wet season.

Avon River.—Rises in Bald Hills, near Navarre, and has the Richardson river and creek, Sandy and Irwell creeks for tributaries; flows northerly for 45 miles, and terminates in a swamp called Boloke; is non-permanent.

Wimmera River.—The main stream and most of the eastern tributaries take their rise in the Pyrenees and the western tributaries from the Grampians. This river takes a north-westerly and northerly course, passing through 130 miles of very flat country, and discharges into Lake Hindmarsh, which is 12 miles long and 5 miles wide and contains fresh water. From this lake is an outlet leading into Lake Albacutya, whence an outlet creek leads to a large plain called Wirringree; but this creek has not flowed for many years, so that Lake Albacutya may be considered the termination of the waters of the Wimmera. The supply to this river is almost exclusively from surface drainage, hence it does not flow in summer.

*** *The whole of the rivers above, and their tributaries, flow northerly and with the exception of the Wimmera and Avoca, which terminate in lakes without outlet, eventually discharge into the Murray, taking their rise in the Great Dividing Range or spurs connected therewith.*

RIVERS AND CREEKS NORTH OF GREAT DIVIDING RANGE—*continued.*

River or Creek.	Locality.	Sectional Area in square feet.	Mean Velocity per second in feet.	Discharge per second in cubic feet.
Murray River......	At Albury, below Mitta-Mitta and Little River	2248·0	1·185	2663·880
Murray River......	Below Ovens junction	5042·7	0·59	2975·1
Murray River......	Above junction of Goulburn	...	...	2411·
Murray River......	At Echuca, below the Goulburn	2479·9	1·596	3967·92

REMARKS.

The Murray.—The Murray receives the drainage of all the Victorian rivers and creeks that flow northward from the Great Dividing Range, saving such as terminate in swamps or lakes, as the Wimmera, Avon, and Avoca rivers. It rises in the Australian Alps, at Forest Hill, and proceeds northerly for 60 miles (receiving intermediately an east branch from Mount Kosciusko) to the junction of the Cudgewong Creek, whence its course is westward for 180 miles to the junction of the Goulburn, and thence north-westerly to the western boundary of the colony for 320 miles, presenting a general length of northern boundary of 560 miles, or measured circuitously along its bends about 1600 miles. Its width from Albury to the Campaspe at summer level, varies from 200 to 240 feet ; it is supplied above the junction of the Mitta-Mitta to its source by permanent streams from the Australian Alps, which convey spring water from the primitive granitiform rocks constantly, and melted snow for three months in the year. The aggregate of supplies amounted to 2037 cubic feet per second on the 21st December, 1859, being fully one half of the whole summer discharge above the confluence of the Edward River in the Wimmera district, and was drained off an area of only 2500 square miles, while the united basins of the Mitta-Mitta, Little River, Ovens, and Goulburn, comprising 11,300 square miles, or more than four times this area, delivered only 2778 cubic feet per second at the same time, thus demonstrating the superior water-bearing capacity of this basin at the source of the Murray to that of its great tributaries. Below the junction of the Goulburn the Murray does not receive any tributary waters from the Victorian side during the dry season, but it is considerably reinforced by the confluence of the Murrumbidgee and Darling rivers from the Sydney side, which drain a considerable portion of New South Wales. It finally discharges into the sea at Encounter Bay, in the South Australian territory, through which it flows for one-third of its length. It has been successfully navigated up to Albury.

RIVERS AND CREEKS SOUTH OF THE GREAT DIVIDING RANGE.

Date of Observation, 21*st December*, 1859.

River or Creek.	Locality.	Sectional Area in square feet.	Mean Velocity per second in feet.	Discharge per second in cubic feet.
Glenelg River	Two chains below the junction of the Wannon	18·05	0·935	17·217
Glenelg River	Just above the tidal influence	343·00	0·122	41·84
Wannon River, a tributary of the Glenelg	Four chains above its junction with the Glenelg	12·40	0·786	9·752
Eumeralla River...	At the Portland road crossing	126·00	0·00	0·00

REMARKS.

Glenelg River.—This river rises between the Victoria and Sierra Ranges, to the west of Mount William, and is derived from springs and ordinary rainfall; parts of it are dry during the latter end of summer, as for instance at and in the neighborhood of Balmoral and Harrow; but adjacent to such parts there are large deep pools of permanent fresh water. The quality of the water generally speaking is good, although in summer brackish portions are to be found. The bed is sandy, and the banks heavily timbered with gum, and for the greater part precipitous and high. The portion of the river between Dergholm and junction with Wannon could be made available for undershot water-wheels. The height above the sea at Harrow is about 314 feet, and at junction of Wannon 132 feet. The difference at Dartmoor between the summer and highest flood level is 49 feet, ascertained last year in October, at the mouth of the Wannon; on 21st December, 1859, the difference was 21 feet.

Wannon River.—Rises on the east of the Sierra Ranges, to the south-west of Mount William, and is derived from springs and ordinary rainfall; it passes through Dunkeld, Cavendish, Bochara, and thence to Sandford, where it unites with the Glenelg; it scarcely runs at all in the latter end of summer between its course and Cavendish, and but very little to the junction of the Grange Burn, (which is a running stream in the driest seasons); from this point to the junction with the Glenelg, it is available for undershot motive power, and passes through a large tract of suitable land for agricultural purposes. The quality of the water is very good from the source to the junction of the Grange Burn, and afterwards it is slightly brackish in places to the Glenelg. The height of this river above the sea is at Tahora about 198 feet, and at Bochara, above the falls, about 385 feet.

Eumeralla River.—Flows into Yambuk Lake, which is the estuary. The tide flows up five and a half miles, and boats can proceed this distance; at six miles the flats commence, and extend four miles upwards, averaging

Rivers and Creeks South of Great Dividing Range—*continued.*

River or Creek.	Locality.	Sectional Area in square feet.	Mean Velocity per second in feet.	Discharge per second in cubic feet.
Shaw River	...	...	...	0·00
Moyne River	...	...	...	...
Spring Creek	...	...	...	...

REMARKS.

half-a-mile in width, and unfit for any purpose but grazing. 22 miles from the estuary is the junction of Breakfast Creek from the westward; and at 45 miles it flows out of Buckley's Swamp, which is the drainage of a large extent of country west and northward of Mount Rouse.

Shaw River.—Flows into Yambuk Lake; a mere winter stream, passing through and connecting various swamps and flats; has some permanent good water-holes; rises about 30 miles from the lake, on W. Carmichael's station.

Moyne River.—Joins the sea at Belfast; has a shifting sand-bar, the depth of water on which is sometimes only six inches, and seldom reaches four feet in depth. The tide flows about three miles up, but boats cannot pass Belfast except in winter. 13 miles from the bar are the falls, about 20 feet over trap rock, available for a water-mill about six months in the year. At 17 miles is the outlet of Torrens Marsh, which extends about four miles; this large flat has very good soil, but is deeply flooded in winter, only a small portion could be made available for cultivation. It takes its rise about five miles above Kangatong station, at 33 miles from the bar is a flat in which is a small spring.

Spring Creek.—Takes its rise from springs on the north-east side of Mount Rouse; by the bends in it the distance between its junction and the Merri Rivulet is about 43 miles. Four miles up is the junction of Bullabull Creek, a mere drainage. At Woolsthorpe, 11 miles upwards, it is an open flat of good soil, averaging half-a-mile in width, and over six miles in length; the whole of this might be made available for cultivation by cutting a drain connecting the pools on this flat; above the flat a dam might be formed, so that it might in summer be irrigated if necessary. 15½ miles up is the junction of Youl's Creek from the eastward, a mere drainage of very brackish water; 18½ miles Ware's Creek from the westward; 26 miles junction of Back Creek, having very good water, and takes its rise from springs south-west side of Mount Rouse; 28 miles McArthur's Creek from the eastward, water very salt; 32 miles Buckland's dam, and junction of Double Creek; this double creek runs parallel for the distance of four miles, the diversion of the two being a trap rock ridge about five chains wide; at 34 miles mere flats of good soil, various widths, and extending nearly to the springs, all of which would require draining to make available for any purpose save grazing.

RIVERS AND CREEKS SOUTH OF GREAT DIVIDING RANGE—*continued.*

River or Creek.	Locality.	Sectional Area in square feet	Mean Velocity per second in feet.	Discharge per second in cubic feet.
Merri Rivulet	...	...	...	...
Merri River.........	...	...	...	...
Hopkins River......	Parish of Langi Ghiran, near Ararat	...	...	0·00
Hopkins River......	Near Green Hill, Ararat	...	...	0·00
Hopkins River......	Chatsworth...........	...	...	0·00
Hopkins River......	At Wangoom, above the rapids, five and a half miles from the mouth, and at Mr. Allen's	...	0·25	27·000

REMARKS.

Merri Rivulet.—This rivulet is the drainage of a flat swampy country westward of the telegraph lines. The banks below Drysdale station are very steep, high, and stony ; many springs along the banks, and some few permanent good waterholes.

Merri River.—Joins the sea at Warrnambool. Boats can proceed to near Woodford for a distance of 12 miles. At five miles from the bar it is joined by the Yangery Creek, a mere drainage from stringy-bark country; 16 miles from the bar is the junction of Manifold's Creek which forms the drainage from Lake Carlcarronge: this lake could be easily made available for the purposes of irrigation ; 18 miles from the bar is the junction of two creeks —the Merri Rivulet and Spring Creek.

Hopkins River.—Forms the eastern boundary of the county of Villiers; the outlet to the sea is a narrow rocky bar one mile eastward of Warrnambool ; the tide flows five and a half miles up, to which distance boats can proceed ; at this spot are rapids formed by large boulders and flat basaltic rocks ; nine miles above the rapids Brucknell Creek joins it from the eastward (Brucknell Creek has a narrow deep bed, very good water, and flows throughout the year, and is the drainage of a large portion of the impenetrable scrub in the county of Heytesbury) ; half a mile above Brucknell Creek are the falls, 40 to 45 feet in height ; three miles above the falls is the junction of Emu Creek or Black's Creek from the east. To this distance from the rapids the pools are long and deep, and have good water ; above, the pools become much less, and the water rather brackish, and some too salt for use. About 30 miles from Emu Creek is the junction of the Saltwater Creek from the east and Muston's Creek from the west. Muston's Creek takes its rise from a small flat, with no apparent spring, about 12 miles north-east from Mount Rouse ; it has very bad water in small pools during summer, is easily flooded and soon subsides. The banks of the Hopkins are high, steep, and stony ; it is liable to very high floods : in 1854 the height at Allansford bridge was 22 feet above summer level. Above

RIVERS AND CREEKS SOUTH OF GREAT DIVIDING RANGE—*continued.*

River or Creek.	Locality.	Sectional Area in square feet.	Mean Velocity per second in feet.	Discharge per second in cubic feet.
Mount Emu Creek	26 yards above its junction with the Hopkins	4·62	2·08	9·609
Mount Emu Creek	Below junction of Baillie's Creek	...	...	0·00
Gnarkeet Chain of Ponds	...	...	...	0·00
Curdie's Creek	...	...	...	...

REMARKS.

Muston's Creek are four other minor winter streams from the westward; there are several places in this river could be made available for water mills. The Hopkins rises in the southern slopes of the Pyrenees, about 80 miles in a northerly direction from its confluence with the sea; although its northern portion ceases to flow at certain seasons, it nevertheless affords to the counties of Hampden and Villiers a good supply of water for stock, contained in water-holes from a few yards to a quarter of a mile in length, and occasionally of great depth.

Mount Emu Creek.—Issues from the southern sheds of the Pyrenees and from Lake Burrumbeet, and flows in a southerly direction as far as the north-west angle of the county of Heytesbury, a distance of about 65 miles in a direct line, but it is very tortuous in its course thither; then it takes a westerly course for about 20 miles to its junction with the Hopkins, about 10 miles from the ocean; it derives its supplies in a similar manner to the Hopkins. This creek, however, intersects a tract of country presenting higher evidences of volcanic action than that through which the Hopkins passes, and this may account for the presence and flow of water in this creek during seasons while the other has ceased to flow. In its southward course it receives the contents of copious springs; northward, towards its source, the supply is more from rainfall, although there are springs immediately at its source.

Gnarkeet Chain of Ponds.—Rises on the south and east slopes of Mounts Widderen and Bute, about 22 miles north from Lake Corangamite, into which it falls; the water, varying in quality, is contained in holes of limited dimensions, many of which become dry in summer. The supply is chiefly derived from ordinary rainfalls which, when unusually heavy, causes a flow in the creek for a limited period.

Curdie's Creek.—Takes its source from Lake Purrumpete, as also from springs and drainage from the southern and eastern slopes of Mount Laura and Mount Naringal, then it enters an unsurveyed and densely wooded tract of limestone country. It gradually increases in importance as it nears the sea coast, fed by numerous supplies from the watersheds which divide it from the Gellibrand on the east, Mount Emu Creek, Cudge Creek, and the Hopkins on the west. The flow of water is permanent and copious.

RIVERS AND CREEKS SOUTH OF GREAT DIVIDING RANGE—*continued.*

River or Creek.	Locality.	Sectional Area in square feet.	Mean Velocity per second in feet.	Discharge per second in cubic feet.
Gellibrand River...	...	...	...	...
Barwon River......	Rickett's Marsh......	73·50	3·56	262·00
Leigh River.........	...	...	...	0·00
Moorabool River...	At junction with Lal Lal Creek	0·46	0·193	0·0887
Werribee River ...	At Bacchus Marsh...	...	...	2·2
Lerderderg River, a tributary of the Werribee	At Bacchus Marsh...	...	...	3·25

REMARKS.

Gellibrand River.—Rises in the ranges in the interior of the county of Polwarth, and passes in a south-westerly direction to the sea, which it enters 22 miles west from Cape Otway. Of this river little is known, it having been but little explored, being situated in country difficult of access.

Barwon River.—Takes its source in the Cape Otway ranges, and falls into the sea at Mount Colite, after traversing through 80 miles of country. It has a drainage basin of 1432 square miles.

Leigh River.—Flows from the Great Dividing Range southerly for 50 miles, and joins the Barwon after draining 373 square miles of country.

Moorabool River.—Rises in Great Dividing Range, and flows southerly, joining the Barwon at Fyansford. It is about 60 miles long, and has a drainage basin of 342 square miles.

Werribee River.—The total length of the Werribee is about 56 miles. At Bacchus Marsh it attains a level of about 400 feet above the sea; at Ballan about 1600 feet; and the highest elevation of the Blackwood Ranges, from whence it takes its rise, is about 2000 feet. In the vicinity of Ballan it often wholly ceases to flow during the summer months, as also as far down as Bacchus Marsh. The Korjamuneip Creek, next the Lerderderg River, is the most constant tributary to the Werribee, having for its source numerous springs in the ranges. Above the crossing of the Ballan and Blackwood road it divides into two branches, of which Korweinguboora is the most permanent. Numerous mineral springs are to be found in the ranges at source of this latter, and one of ærated water of effervescing strength.

Lerderderg River.—Is the most permanent tributary of the Werribee, and has seldom been known to fail in the vicinity of Bacchus Marsh. Its waters are yellow and muddy with the sludge of the Blackwood miners, to whom it is of great importance for nine months in the year. Advantage has been taken of its waters at Bacchus Marsh for irrigating purposes with most satisfactory results.

RIVERS AND CREEKS SOUTH OF GREAT DIVIDING RANGE—*continued.*

River or Creek.	Locality.	Sectional Area in square feet.	Mean Velocity per second in feet.	Discharge per second in cubic feet.
Macedon River, or Riddell's Creek, a tributary of the Saltwater River	At Crossing of Railway	...	...	2·5
Saltwater River, main eastern branch	Brocks' Hill	...	...	2·5
Yarra Yarra River	At Hawthorn, 100 yards below bridge	1297·00	0·4128	535·00
WooriYaloakCreek	Near Bryerty's station	82·28	0·61	50·19
Running Creek ...	Mooroolbark, four miles above Saw Mills	1·718	1·38	2·37
Running Creek ...	Two miles above Saw Mills	11·8	1·13	13·37

REMARKS.

Macedon River.—Source in numerous springs gushing from the base of Mount Macedon. The Gisborne branch of this stream is by far the longest, yet its discharge is so small at present as to be scarcely discernible.

Saltwater River.—Rises in the Macedon Ranges, the southern slopes of which abound in springs, giving rise to several permanent streams, the whole uniting form one stream about 13 miles above the junction of the Saltwater River with the Yarra. At about eight miles up from this place, on the north side of Braybrook, it does not flow in summer, but consists of a series of large capacious water-holes of fresh water. At half a mile below this, at the fords, are copious salt springs from the adjacent trap formations which generate a flow of from five to ten cube feet per second. Nearly from this point down the river is navigable, the water-level being maintained by tidal influence from the Yarra. Drainage basin, 500 square miles.

Yarra Yarra River.—The permanent streams which combine to form the Yarra are distinguished by their copious flow of water at all seasons and rise in granite or porphyritic ranges covered with dense and luxuriant vegetation, of which the following are the principal as yet surveyed,—rivers Plenty and Don, Badgers' Creek, Watts' Creek, Woori Yaloak Creek, and Running Creek, exclusive of which the upper basin contains a great number of fine permanent streams, but little explored. The remaining tributaries are merely receptacles of surface drainage and are not permanent. The length of the Yarra to the sea is about 70 miles ; its drainage basin, 1500 square miles.

Woori Yaloak Creek.—A tributary of the Yarra, rising from springs in the Dandenong Ranges. It is a fine permanent stream.

Running Creek.—Rises from springs in the Dandenong Ranges.

Gipps Land.*

Observations taken in February, 1860.

River or Creek.	Locality.	Sectional Area in square feet.	Mean Velocity per second in feet.	Discharge per second in cubic feet.
Franklin River ...	...	...	...	...
Agnes River.........	...	...	...	...
Albert River.........	One and a quarter miles above Alberton	...	...	36·00
Tarra River.........	Ten miles above mouth	...	...	22·5
Merriman's Creek	...	...	...	...

REMARKS.

Franklin River.—Flows southerly into Corner Inlet, from the Streletzski Ranges whence it rises, it is navigable for a few miles and has a muddy bottom where within tidal influence, but higher up the water is bright and clear, flowing over granite, sandstone, schist and quartz pebbly bottom, and in a larger volume than in the low country where the porosity of the adjoining land absorbs a portion of the discharge. In this river are to be found many varieties of fish; in the lower part, near the mouth, are those kinds peculiar to salt water, and higher up such as are entirely confined to inland water.

Agnes River.—Rises in the Streletzski Ranges, and flows southerly into Corner Inlet, and is in all respects the same as the Franklin.

Albert River.—Rises in the Streletzski Ranges and discharges into an inlet at Palmerston where Port Albert lies. It is navigable for vessels of light draught up to Alberton, about seven miles from Port Albert. Its length is about 20 miles ; the supply is from springs and surface drainage ; it is adapted for irrigation and for water supply to the township of Alberton. The difference between summer and floods is about three feet ; the water is good.

Tarra River.—Flows southerly about 25 miles from the Streletzski Ranges from which it takes its rise, and discharges into an inlet two miles east of the Albert. It is available for water supply to Port Albert. Vessels of light draught can proceed as far as Tarraville.

Merriman's Creek.—Is the boundary between North and South Gipps Land, and is a small rivulet of pure, clear, well-tasted water, taking its rise in a swamp, and flowing the entire year. Excepting during floods it has seldom any open discharge into the sea, the greater part of the water being absorbed, and the remainder percolating through the ninety-mile beach.

* The information relative to the Gipps Land streams is derived principally from Mr. Dawson's valuable reports.

GIPPS LAND—*continued.*

River or Creek.	Locality.	Sectional Area in square feet.	Mean Velocity per second in feet.	Discharge per second in cubic feet.
La Trobe River....	Above junction with the Thomson	...	...	401·31
La Trobe River.....	Below junction of the Thomson	...	...	674·1
Thomson River.....	Above junction with the La Trobe	...	...	250·0
Avon River..........	Stratford...............	...	...	72·6

REMARKS.

La Trobe River.—Is of considerable importance, flowing from west to east, and taking its rise in the Mount Baw Baw Ranges near the source of the Yarra, which river it resembles much in its physical features. Before entering the low country it is joined by a number of tributaries, many of which are equal to itself in size, which abound in fish. After leaving the ranges the La Trobe enters a magnificent country, meandering through which, it is joined by the Thomson, which previously receives the waters of the McAlister. These three rivers water what is essentially the garden of Gipps Land, consisting principally of open plains fringed with light timber, and sheltered from hot winds by the Australian Alps; the whole of this district presents peculiar facilities for being irrigated on a comprehensive scale by water brought from the base of the mountains. The La Trobe is navigable for small steamers as high up as Kilmany Park; by clearing away the logs and other obstructions, the navigation could be extended up to the foot of the ranges, as the depth varies from two to four and a half fathoms, and the width from 30 to 80 yards. As this river and its principal tributaries take their rise in the Baw Baw Ranges and Australian Alps, they are supplied from springs and the melting of snow in addition to surface drainage, and are subject to sudden and heavy floods, especially in the spring, when they sometimes rise in a few hours from 12 to 18 feet, which is often solely occasioned by the effects of a few warm days melting the snow on the mountains. The La Trobe flows into Lake Wellington, which is fresh at all times.

Thomson River.—Is a tributary of the La Trobe, and rises in the Australian Alps, being supplied therefrom by springs and melting of snow besides surface drainage from its own basin; it is navigable for small steamers for a few miles above Sale, its depth varying from two to four and a half fathoms, and width from 30 to 80 yards; it has the McAlister for a tributary, and with it is subject to the same general remarks that have been applied to the La Trobe above.

Avon River.—Flows in a south-easterly direction, and discharges into Lake Wellington, and although very wide and deep up to Nuntin Creek, is comparatively a short river, and very little if at all affected by the melting

GIPPS LAND—*continued.*

River or Creek.	Locality.	Sectional Area in square feet.	Mean Velocity per second in feet.	Discharge per second in cubic feet.
Mitchell River......	Lucknow	...	...	497·0
Nicholson River ...	At township, 10 miles up	...	...	6·72
Tambo River	Crossing of Swift's Creek road	...	...	22·00
Tambo River........	One and a half miles below crossing	...	...	9·5

REMARKS

of snow; the upper parts are on occasions subjected to very heavy floods rising from 18 to 25 feet above summer level, and flooding all Nuntin Plain; this, however, does not occur on the average above once in seven years, and then the flood is soon drawn off by the width and depth of the river, below which the depth varies from two and a quarter to six fathoms, and the width from 80 to 150 yards. Within a mile of its mouth the Avon is joined by the Perry River, which is only a chain of waterholes, but rises to a considerable stream during floods; at its junction with the Avon it forms an estuary navigable for two or three miles.

Mitchell River.—Is formed by the confluence of the Dargo and Wangangarra rivers which, with their principal tributaries, rise in the Australian Alps, and consequently owe a considerable part of this supply during spring to the melting of snow, and throughout the year to springs in those ranges. The Mitchell is joined further down by the Wentworth, flowing southwards from the same ranges, and from them to its discharge into Lake King it receives a number of minor tributary creeks, the general direction of all the streams from the Alps to Lake King being south-easterly. The Mitchell is from four to five fathoms deep from its mouth for about seven miles up; the main stream passes through about 70 miles of country.

Nicholson River.—Flows southerly into Lake King, and is about 40 miles long. It is navigable for about 10 miles from its mouth, along which its width varies from 15 to 150 yards, and the depth from one to four and a half fathoms.

Tambo River.—Rises from springs, from comparatively table land on the Great Dividing Range near Lake Omeo, and flows southerly from thence until it discharges into Lake King, traversing through about 70 miles of country of granite formation excepting a small tract of limestone country near its source; it is fed by some few small running streams, and at about 12 to 15 miles above Bruthen it is joined by another stream named the Timbarra, of nearly the same size as itself The Tambo is very liable to floods, from Bruthen upwards, rising many feet in a very short period, such floods being caused by heavy falls of rain and the melting of snow upon the surrounding mountains and ranges.

GIPPS LAND—*continued.*

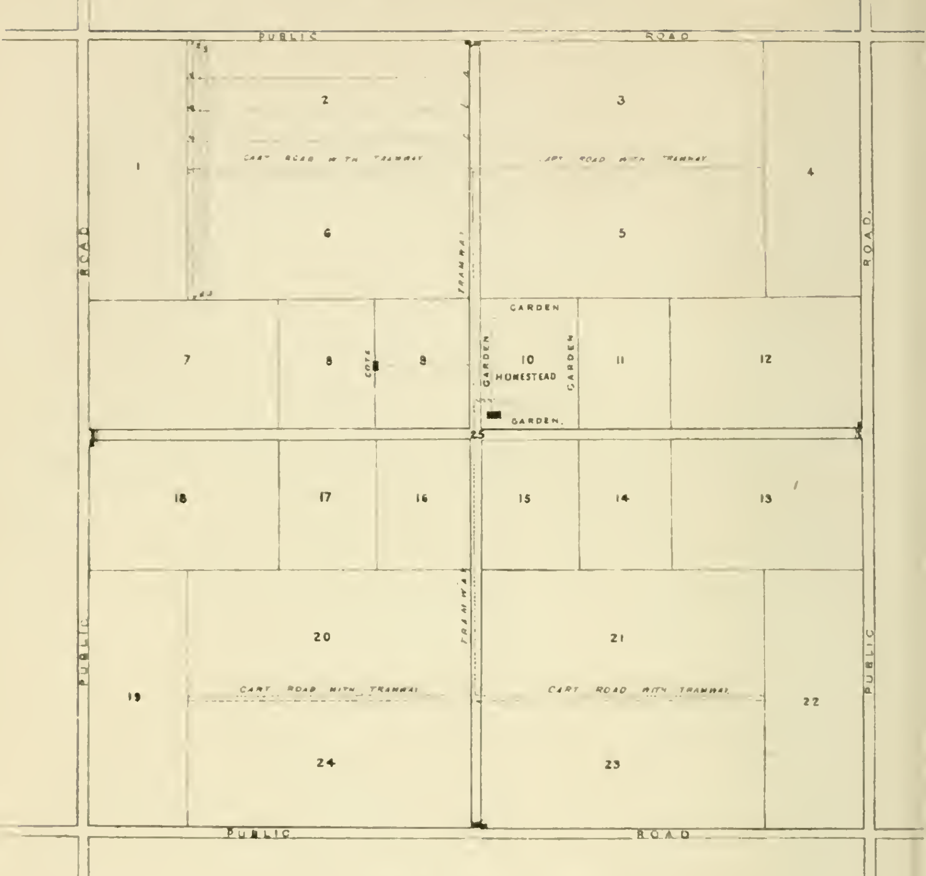
River or Creek.	Locality.	Sectional Area in square feet.	Mean Velocity per second in feet.	Discharge per second in cubic feet.
Snowy River........	...	...	...	...
Genoa River.........	...	...	...	...

REMARKS.

Snowy River.—Is the longest in Gipps Land, but rises in New South Wales, in the Australian Alps, or Snowy Mountains, and is subjected to very heavy floods, often rising 20 feet in a night. Were it not for the snags, it would be navigable for a very considerable distance from its mouth; it is, however, difficult of access for any vessels excepting those of light draught, as a bar of shifting sand stretches across the entrance. This river is admirably adapted for the propagation of European fish.

Genoa River.—Is the most easterly of all the colonial rivers. It rises in ranges in New South Wales, and flows in a south-easterly direction to the sea, which it joins about 12 miles west of Cape Howe, the easternmost extremity of the colony.

PLAN OF AGRARIA DOMAIN.



Scale 20 chains to an inch

REFERENCE.

No.		A.	R.	P.
1.	West special ground	26	0	0
2.	Far north-west field	39	0	0
3.	Far north-east field	39	0	0
4.	East special ground	26	0	0
5.	Near north-east field	39	0	0
6.	Near north-west field	39	0	0
7.	North cow pasture	26	0	0
8.	Cote paddock	13	0	0
9.	Hospital crofts	13	0	0
10.	Homestead	13	0	0
11.	Clover paddock	13	0	0
12.	Vineyard	26	0	0
13.	Orchard	26	0	0
14.	Lucern paddock	13	0	0
15.	Home paddock	13	0	0
16.	East sheep pasture	13	0	0
17.	West sheep pasture	13	0	0
18.	South cow pasture	26	0	0
19.	Water meadow	26	0	0
20.	Near south-west field	39	0	0
21.	Near south-east field	39	0	0
22.	South special ground	26	0	0
23.	Far south-east field	39	0	0
24.	Far south-west field	39	0	0
25.	Inner or private roads	16	0	0
		640	0	0

ESSAY

UPON

The Agriculture of Victoria,

WITH REFERENCE TO

ITS CLIMATE ADVANTAGES, AND THE GEOLOGICAL AND CHEMICAL CHARACTER OF ITS SOILS;

THE ROTATION OF CROPS, AND THE SOURCES AND APPLICATION OF MANURES; THE ZOOLOGICAL ECONOMY ADAPTED FOR THE AUSTRALIAN COLONIES; AND THE INTRODUCTION OF COTTON AND OTHER WARM-CLIMATE PRODUCTS INTO AN AUSTRALIAN SYSTEM OF HUSBANDRY:

BEING,

WITH SOME ADDITIONS, WHICH ARE PRINTED IN A LESSER TYPE,

THE ESSAY WHICH BORE THE MOTTO

"AGRARIAN."

ILLUSTRATED BY A PLAN OF A MODEL DOMAIN.

BY WILLIAM STORY.

CONTENTS.

THE THIRD, OR VICTORIAN SPECIAL CULTURE BRANCH.

CONTENTS.

AGRICULTURAL SUBJECTS DISCUSSED.

ESSAY.

The agricultural statistics of the colony of Victoria, as given in the recent report on its resources, show, that of the three millions of acres, which in 1859 had passed into private ownership, less than three hundred thousand acres had been brought into cultivation, which was thus cropped:—

	Acres.
Wheat	78,234
Oats	77,526½
Barley	5,322
Rye 57½, Maize 480, Beans, Peas, and Millet 264¾	802¼
Potatoes	30,026¼
Turnips 332, Mangel-wurzel 185¼, Red Beet 3¾, Carrots and Parsnips 96½, Cabbages 75 ...	692½
Hay of the Cereals Wheat, Oats, and Barley ...	85,606¾
Hay of Rye Grass and Clover, ...	556
Green Forage of the Cereals Wheat, Oats, and Barley, ...	3,779½
Green Forage of Maize 315¼, Lucern 283, Clover and Vetches 328, Sorghum 600¾ ...	1,027
Permanent Artificial Grasses	2,602½
Gardens 5486¼, Orchards 397½, Vineyards 547½, Tobacco 66½, Onions and other crops 288¼	6,786
Land in fallow preparation for cultivation ...	5,998½
	298,959¾

Wheat and potatoes, and also the cereals (as hay and green forage), appear to have taken up proportionate areas in accordance with my preconceived notion of a fair course of colonial cropping; but the other crops are all in random quantities, the permanent artificial grasses being surprisingly low in quantity, but oats being greatly in excess of any sustainable course of cropping. As the bulk of the cereal hay, and much of the cereal forage was proba-

bly oaten, it may be assumed that half the cultivated land of the colony was in oats; which are known to be the most impoverishing crop of the cereals.

As this result as to oats indicates a partiality for that crop, which, if not checked, may become a vulnerable point in Victorian husbandry, I shall, in the way of monition, state the prejudicial effect which over-oating had on an English arable parish, which in olden time had been proverbial for the growth of its wheat and oats.

That parish, in the days of Jethro Tull, had adopted his triennial course of fallow, wheat, and oats in perpetual succession, and had clung to it a century, when I became connected with its agency management. My connection lasted thirty years, and save upon some land which had remained a pasturage common for sixty years, after the adoption of the course, and had therefore been but little under it, I never saw a crop of oats which repaid the grower, though the wheat crops continued good, and fully sustained the wheat-growing reputation of the parish. On consulting old men as to the cause of the oat failure, I found, that after a dozen rounds of the new course, everybody's oats had failed, and the parish had never yielded more than half crops since, but they all admitted that wheat had never failed. I attach more than ordinary importance to the experience of this parish, because owing to there being coal and lime works in its neighborhood horse labor had been all the while in great demand, and as a consequence, many oat-fed horses had returned, in their contribution to its farmyard manure much of the oat ingredient, though but little of the wheat ingredient had been returned, because the parish was thinly populated, and nearly all its wheat was consumed in the mining districts; moreover, the comparative goodness of the oat crops on the newly broken up land, evidenced that the ancient oat growing repute of the parish was well grounded, and my inference was that oats, continuously grown in quick succession, do affect land prejudicially, and that excessive oat growing is bad husbandry, and is as such to be denounced.

The more recently published statistics for the year ending the 31st March, 1860, show that the quantity of land then in cultivation, had augmented to 357,764¼ acres, of which, almost a third of the whole, viz., 107,078¼ were in wheat, and 5556½ acres in permanent artificial grasses; both of them very satisfactory

results. Another source of satisfaction is that, at a recent agricultural show, Victorian wheat beat in fair competition the wheat of South Australia, which by its admitted merit, at the great English Exhibition of 1851, had won for that colony the leadership in Australian agriculture. I was also gratified on averaging the yield of the last year's wheat, to find that it reached $21\frac{3}{8}$ bushels to the acre throughout the colony; which, considering the primitive husbandry yet practised, contrasted favorably with the general average of England.

This preliminary view of the existing state of Victorian culture, appeared to me properly to preface an Essay, intended to suggest a system of husbandry, adapted not only for Australia Felix (as the colony was at first aptly named), but also for first-class land of any other Australian colony, which may choose to adopt it.

The importance of the colony of Victoria, which nearly equals in area the entire island of Britain; the excellency of its climate, and its soil; the conveniency of its position, and of its division by the mountain ranges which bisect it; the uniformity in shape of the Land Act sections, and the dignified size of the embryo domains which will result from its maximum grants, under the recently passed Land Act; the enlightened era in which the agriculture of the colony has to be developed, and the commercial and filial connection which subsists between "garden cultured England" and the colony; the vicinage of Victoria to China, Japan, India, and the Australasian islands, which have long been the monopolizers of special products, and the friendly and commercial relations of the colony with every country of the earth which has animals and plants, worthy of Australian reception and attention, to offer in exchange for our Kangaroos and Orange-trees; and the probability that the mutual wants of the gold miner and of the agriculturist, will lead to the effective co-operation of the two interests, and result in the establishment of an extensive system of water conservation and supply, for systematic irrigation; all concur in demanding that the agriculture of the colony, (which has the advantage of a *de novo* beginning,) shall, from the first, assume dignified position as an inductive science, and be relieved from the necessity of having to squat as a mere routine plough-tail craft, unworthy of exaltation, when necessity for the primitive husbandry of pioneer settlement shall have passed away.

The Alpine ranges, to which I have before alluded, and which so conveniently divide the colony into approximate moities, point clearly to the inference that the sub-tropical products of cane-sugar, coffee, spices, cotton, indigo, pepper, &c., and the super-varieties of rice and other products requiring a given degree of heat will have better development in North Victoria than in the southern moiety of the colony; and that the cereals and Anglo-Australian products will have better development in South Victoria than in the northern moiety of the colony. This important feature in the geography of the colony is probably predestined to give a distinctive character to the agriculture of each locality, and an Austral-Oriental feature to the moiety having its watershed towards the River Murray.

It is obvious from the quoted statistics, that though individuals have made praiseworthy beginnings, the agriculture of Victoria is yet inceptive, and has no pretension to system. Being anxious that the recently passed Land Act and Victorian agriculture shall start well together, I have bestowed some thought upon the division and arrangement which will best adapt the Land Act grants for the mixed system of husbandry which it will be my aim in this essay to propound; and in producing an arrangement under which the cultivators of maximum grants, and of minimums, and of intermediates, may pursue similar husbandry, and co-operate, if so minded, in the establishment of a system sufficiently universal to be appealed to as the standard practice of Australia.

To be well based, Victorian agriculture should be grounded on English husbandry, so far as Anglo-Australian cropping and objects are relevant; and on the best warm-climate culture of other countries as to cropping and objects hitherto foreign to English culture, but which the genial climate and the fine soil of Victoria predispose it to produce.

As the English term "farm" does not do justice to the tenure of a Victorian grantee, who, by being luckily the owner as well as cultivator of his grant, is not in the true sense of the word a "farmer;" I shall reject these terms as misnomers in Victoria and substitute in their stead those of "domain" and "agriculturist:" not that I have any dislike to the word farm, which is dear to me by association, and because it exemplifies in the sterling dignity which has attached on British farmers, as a class,

the effect of free institutions in elevating both character and calling; for be it observed that neither the word farmer nor the calling which it was intended to designate had aught dignified about them, when the word "farm" was jostled out of a Norman-French vocabulary into the English language, and as both the calling and its fraternity are yet without dignity on the French side of the Channel, the inference, that the dignity is altogether of British origin, is in my opinion justifiable.

Mixed husbandry is certainly the best for the community, and the safest for the husbandman, because it rarely happens that the "plough and the pail," or the "fleece and the vineyard," are despondingly bad at the same time. The Flemings have a proverb, that "without forage no cattle; without cattle no manure; and without manure no crops;" and there are many recorded instances in which in trying times the profits of one department of an establishment have met the losses of another. The fruit of experience is always worth gathering, and I am inclined to think, that notwithstanding the amazing development which sheep-farming and the patriarchal pastoral system have received since they became Australian, the colony may experience famine or become poverty bestricken in the midst of resources if one department of rural economy shall be allowed to keep under the due development of another. Time has been when Australian flocks and herds were valueless, and ruin was the consequence, because the colonists had no "wine and oil," or "butter and cheese," or "grain and tillage produce," to fall back upon to meet pressing payments in some cases of no great magnitude, probably in many, for produce which their own land would have produced, even of better quality than that in respect of which their overdue bills (then working ruinously) were given; and similar times as to panic may recur again, but not I trust with ruinous results.

In a vista of the future, near enough for mental ken, I saw the germ of Australian agriculture (a Victorian seedling) vegetate, and watched it till it reached a sapling's growth, and bud for branching into triune form. The first shoot bore affinity to British arable culture, but was amplified by the admission of rice, sugar-beet, maize, and such other warm climate productions as fall in with an annual routine of field culture. The second shoot bore affinity to British grass-land, and stock and dairy husbandry,

as expanded by European soiling management, and Australian shepherding; but it embraced in its scope greater animal variety than had been attempted in the pre-existent range of domestication of any one of the four older divisions of the earth. In the third and aspiring shoot I saw so little affinity to British antecedents that I named it the Victorian special culture branch, believing it predestined to give a fruitful and Norfolk pine-like crowning to the goodly tree.

I shall now abandon metaphor and resume my leading aim, which is, to instance in the division and proposed arrangement and management of a well-selected South Victorian maximum Land Act grant of 640 acres, which (in allusion to an agrarian-like feature in the Act under which I assume its ownership to have been acquired) I shall call "Agraria Domain," the proportionate development of each of the three branches of Australian agriculture, with the view of exhibiting their goodly proportions, and of showing into what a dignified and profitable possession, capital, skill, and industry, aided by practical science and the climate of Australia, can transform such a maximum grant.

The square-like shape of a Victorian section facilitates not only convenient subdivision but uniformity with simplicity in arrangement also. Much of the perfection to which Victorian agriculture will doubtless in the sequel arrive will probably, with propriety, be attributed to the method and regularity in conducting operations which judicious domain arrangements will induce. In that of "Agraria" I have aimed at giving areas to each of my three departments which will ensure proportionate development, and at placing the land of each in a convenient position to be managed harmoniously as a whole.

The accompanying plan and reference illustrate the subject; and I may state that by proportionate reduction or enlargement the arrangement will adapt itself to any square area, however large or however small.

On revising for the press in June, 1861, I avail myself of the opportunity to add that I hold it to be the duty of a colony, and especially of such a favored one as Victoria, which is in fact blest with three climates, viz., the temperate one of Southern Victoria, which contrasts favorably with that of Tasmania; the sub-tropical one of Northern Victoria, which contrasts favorably with that of Queensland; and the intermediate one of Gippsland, which combines the advantages of both; to be as self-supporting

as its soil and these climate advantages will permit, and to aim also at being as independent as it can of other communities, not only for its food and clothing, but also for such articles of luxury as have come to be regarded as essentials in common notions of enjoyment—as for instance, tobacco and stimulants, in which parties having the means will indulge, whether the precepts of morality pronounce that indulgence right or wrong; and holding this view, and being persuaded that it is practicable to combine with the culture of the cereals not only the soiling system of Europe, but the production also of such of the textiles and the dye plants as are strictly annuals, and peradventure to some extent, the production of cotton also, in one harmonious annual course, I shall take a wide vegetable range in quest of the objects of that course, and thereby make it a vehicle for introducing Victorian agriculturists to the knowledge of the wide range in cropping which awaits their selection.

It is well known that land delights in change of crop, and that it exerts greater energy in the production of what is new to it than it does in producing repetition crops of kind after kind, however congenial to the land that cropping may be; and such being the case, I shall endeavor so to humor the land under my course, by a regulated succession of changes, that it may be kept up to its highest point of willing yield. It will be my endeavor also, to establish such a rotation as will conduct the operations of a domain with regularity through a longer period than is yet common in rotations; and to indicate the place among kindred or congenial cropping which may be properly taken by posterior introductions into Australian husbandry, without deranging the cycle of the course; my anxiety being that no special culture enclosure shall be unnecessarily crowded by any crop, which can be made to submit to a strictly annual routine, because I have a presentiment that biennial, triennial, and sub-perennial culture will, ere long, ramify to an extent greatly beyond present anticipation, and that the special ground (numbered 22) which I shall set apart for that culture, will always have many urgent demands on its space. It will be my aim also, to subject double or catch cropping, and what I shall designate cereal-pasture, cereal-fodder, and cereal-soiling, yield to pre-arrangement, with a view to proximate certainty in crop calculation.

My domain arrangement assigns 312 acres to the first, or arable department, being, with a moiety of the private road, exactly half the domain. This 312 acres is divided into eight rectangular fields, of 39 acres each, numbered 2, 3, 5, 6, 20, 21, 23, and 24 on the plan, being an arrangement purposely for an eight years' course of cropping. It assigns 169 acres, being numbers 7, 8, 9, 11, 14, 15, 16, 17, 18, and 19, to permanent grass and herbage land, in aid of the fodder and cattle food contributions of the eight arable fields, which, under soiling management, will be the main source of supply for the second or

stock and dairy department, and which I have placed purposely near the homestead, to keep stock, when in pasture, in constant view, and so as to be soon seen and reached in the event of disaster; and it assigns 159 acres, being numbers 1, 4, 10, 12, 13, 22, and 25, to the third, or special culture department.

I have to premise that requirements of greater depth of soil for some purposes than for others, and especial desirability of aspect, and also water supply, may suggest deviations as to some of the foregoing numbers, which may lead to transpositions; but such deviations may be made without deranging the proportionate areas assigned to each department, as, for instance, it may be found that a change of sides between the orchard and the vineyard may be to mutual advantage, or both may change places for the better with the cow pastures, or with some of the special culture allotments, and if so, such transpositions ought to be made. Spot adjustment will probably assign the lowest corner of the domain as the place of the water meadow, in order that (on the catchwater principle) it may receive the last benefit of the water before it leaves the domain.

The less fencing, and the fewer the divisions, so that arrangement is well effected, the better; and I apprehend that the best way to "speed the plough" will be to lessen the number of its turnings when it is in operation. I have, therefore, given to the arable fields a convenient length, in order that when the difficulties which have hitherto beset steam ploughing and mowing, and some other operations, shall have been overcome, steam power shall not be fumed uselessly away in a multiplicity of short turnings. By ploughing lengthwise of the field, and working other operations crosswise, more effectual tillage will ensue than would be the case if all the operations were performed in either direction.

As an effect of the precision in arrangement, derivable from the square shape of a section, I may instance that by simply planting thirty-eight lofty trees, of distinctive character, at equal distances from each other, and from the end fences, along both sides of each of the four quarters of the arablè land (as I have instanced in the fields numbered 2 and 6, as to the trees 1, 2, and 3 of their series), a system of tree marking, or ground ready reckoning, may be provided to adjust and perpetuate the bounds of any acre, or combination of acres, to regulate not only sub-division in

cropping, but also to reckon task work in reaping, &c., &c., &c., by mere sight observation from a tree to its fellow tree in the opposite fence, and counting trees between point and point. By distinctive and contrastive character in trees, I mean that both numbers 1, for instance, may be cedars, both numbers 2, cork oaks, and both numbers 3, larches, and so on; an arrangement which will enable the eye to recognize a fellow tree instantaneously by its outline, and so facilitate the turning up of a division furrow wherever it may be wanted. Ten sorts of trees will suffice as markers, for numbers 11, 21, and 31 may each be the beginner of a repetition series. I may observe that by planting three Lombardy poplars, or any three distinctive lofty trees along the end fences of the arable fields (as I have also instanced by the letters *a*, *b*, *c*, in the before-mentioned field No. 2), at equal distances from the side fences, and from each other, they will serve as fixed points, from which sight observations can be taken for dividing an acre into halves and quarters when small quantities may be wanted for experimental or other purpose. A similar arrangement may be carried into the allotments of the special culture department. If preferred, posts, simply numbered, may be adopted instead of trees, but inasmuch as timber trees must be grown upon the domain, the placing them thus methodically will be simply an exaction of double usur for their standing room. The more agricultural operations can be systemized, the greater will be the certainty consequent on experimental operations. I may add, that by noting in the field the position of any plant or object which has attracted attention in connection with its nearest tree marker, a simple pencil note in a pocket book will make that tree a clue to the location of such a plant or object if it shall be wanted to be found again.

I have accommodated Agraria with a central private road, because by it every field gateway may be made to open nearer to the homestead than by any other arrangement, and all the fields may be entered independently of each other. By keeping the entrance gates of this private road locked, cattle happening to get out of their pastures will, at all events, be kept within the domain, and be saved the fatigue of wandering many miles in quest of a pound, and the risk of infection by contact with diseased cattle; and as there would probably be no occasion for other openings into the domain than by these entrance gates, it

may be kept as private and as free from trespass and intrusion as may be wished. By placing married workmen in cottages at each gate, so many watch places will be provided against depredation. Moreover, the road will give the facility of tramway arrangement for the conveyance of manure from the homestead to and through the arable fields, and of conveying forage and soiling produce from the fields home in the way of back carriage. Paved or clayed channels for the conveyance of liquid manure, or of water for irrigation, might be made along the road, and pipes for the conveyance of purer water for cattle supply might be also laid down along it; and if, in addition to all these purposes, the spare land of the road is made a grove of white mulberries, to supply food for the silk worms of the domain, and to support an avenue of vines (a double purpose to which the mulberry is applied in Tuscany, Lombardy, and some other parts of Italy, and in France also), the road will become a paying part of the domain. I shall only add in regard to the road that I have set it out a chain in width, and that it is placed so as to divide the domain into quarter sections.

With regard to the homestead, I shall for the present content myself with allotting the ample space of 13 acres, in the centre of the domain, as its site. It ought to occupy a commanding position, and though I have in the reference to the plan called No. 10 the homestead, I should probably prefer either 9, 15, or 16, if 10 happened to be flat and the others were convex. Any one, however, of the eight central fields might be adopted as the homestead, without deranging the plan, otherwise than by the transposition in the reference of two or three names to other numbers than those with which I have connected them.

Such being the proposed division and arrangement of the domain, I come now to its proposed culture, first taking the *arable department*. It will be seen by the accompanying tabular statement, that I have aimed at uniformity in the quantity of land yearly in the same crop, and at keeping fields in kindred crop side by side in movement, not only during the course, but in its repetitions also—as, for instance, the two wheat fields; and the two fields in other cereal cropping will always be together, as will also the clover field and the pulse followed by clover, and the potato field and its companion field in green crop, &c., in every

TABULAR STATEMENT OF THE VICTORIAN EIGHT YEARS' COURSE OF ANGLO-AUSTRALIAN CROPPING, FOR LAND OF FIRST-CLASS STAPLE.

	No.	Name.	1st Year.	2nd Year.	3rd Year.	4th Year.	5th Year.	6th Year.	7th Year.	8th Year.	9th Year.	10th Year.	11th Year.	12th Year
First Quarter.	3	Far north-east field	wheat	potatoes	$\frac{1}{2}$ barley $\frac{1}{2}$ rice	clover	wheat	green crops, &c.	$\frac{1}{2}$ oats $\frac{1}{2}$ rye	pulse, &c., followed by catch clover	wheat, and on again in repetition course.			
	5	Near north-east field	wheat	green crops, &c.	$\frac{1}{2}$ oats $\frac{1}{2}$ rye	pulse, &c., followed by catch clover	wheat	potatoes	$\frac{1}{2}$ barley $\frac{1}{2}$ rice	clover	wheat, and on again in repetition course.			
	4 10 11 12	East special ground Homestead........ Clover paddock.... Vineyard	oats	wheat	potatoes	wheat	potatoes	4 planted 10 homestead 11 clover 12 planted						
Second Quarter.	21	Near south-east field	..	wheat	potatoes	$\frac{1}{2}$ barley $\frac{1}{2}$ rice	clover	wheat	green crops, &c.	$\frac{1}{2}$ oats $\frac{1}{2}$ rye	pulse, &c., followed by catch clover	wheat, and on again in repetition course.		
	23	Far south-east field	..	wheat	green crops, &c.	$\frac{1}{2}$ oats $\frac{1}{2}$ rye	pulse, &c., followed by catch clover	wheat	potatoes	$\frac{1}{2}$ barley $\frac{1}{2}$ rice	clover	wheat, and on again in repetition course.		
	13 14 15 22	Orchard .... Lucern paddock .. Home paddock .... South special ground	..	oats	wheat	potatoes	wheat	potatoes	13 planted 14 lucern 15 permanent grass 22 special cropping					
Third Quarter.	2	Far north-west field	..	..	wheat	potatoes	$\frac{1}{2}$ barley $\frac{1}{2}$ rice	clover	wheat	green crops, &c.	$\frac{1}{2}$ oats $\frac{1}{2}$ rye	pulse, &c., followed by catch clover	wheat, and on again in repetition course.	
	6	Near north-west field	..	..	wheat	green crops, &c.	$\frac{1}{2}$ oats $\frac{1}{2}$ rye	pulse, &c., followed by catch clover	wheat	potatoes	$\frac{1}{2}$ barley $\frac{1}{2}$ rice	clover	wheat, and on again in repetition course.	
	1 7 8 9	West special ground North cow pasture Cote paddock...... Hospital crofts	..	..	oats	wheat	potatoes	wheat	potatoes	1 planted 7 made cow pasture 8 permanent grass 9 ditto ditto				
Fourth Quarter.	20	Near south-west field	..	..	..	wheat	potatoes	$\frac{1}{2}$ barley $\frac{1}{2}$ rice	clover	wheat	green crops, &c.	$\frac{1}{2}$ oats $\frac{1}{2}$ rye	pulse, &c., followed by catch clover	wheat and repetition course
	24	Far south-west field	..	..	..	wheat	green crops, &c.	$\frac{1}{2}$ oats $\frac{1}{2}$ rye	pulse, &c., followed by catch clover	wheat	potatoes	$\frac{1}{2}$ barley $\frac{1}{2}$ rice	clover	wheat, and repetition course
	16 17 18 19	East sheep pasture West sheep pasture South cow pasture Water meadow....	..	..	..	oats	wheat	potatoes	wheat	potatoes	16, 17 made sheep pastures. 18 made cow pasture. 19 made water meadow.			
	25	Private road	..	..	..	oats	potatoes	mangl wurzel	road made and mulberry trees and vines planted.					

recurrence, so long as the course is abided by. This arrangement, by concentrating all similar cropping and operations into one locality, will expedite them much. I have made wheat and potatoes the cardinal crops of my course, because of their paramount importance as the chief food of man. It will be obvious that first-class land only can be expected to sustain the course which I am about to prescribe, and I shall therefore, in compliment to my adopted colony, distinguish it from any other course which I may prescribe, by the designation of "The Victorian Course." It may be right to explain that in adjusting the rotations which I suggest, I kept these deductions of experience constantly in view: "Fibrous rooted plants, which throw up seed stems with few leaves, thrive well after those with fleshy roots and many succulent leaves on a branching stem: as, for instance, wheat thrives well after beans, vetches, or clover; and barley and oats after potatoes, turnips, and carrots;" and "perpendicular rooting plants and such as root horizontally, should succeed each other."

The far-famed four-course system of Norfolk, which was long the pride of British husbandry, having at length failed as to two of its crops,—and by that failure proved that the course was too short,—I have thought it right to extend my course to eight years, for which I have, as before stated, provided eight equal sized fields. The course alternates between the cereals as to one moiety of the cropping, and as to green crops, roots, pulse, maize, and clover, &c., as to the other, and runs thus: (1) wheat; (2) potatoes; (3) barley and rice; (4) clover; (5) wheat; (6) green crops and roots, &c.; (7) oats and rye; and (8) pulse, &c., and maize, &c., followed by catch clover; and then wheat again, and on in repetition course. The quantity yearly in each crop is intended to be uniform, and to stand thus: wheat, 78 acres; barley, 19½; rice, 19½; oats, 19½; and rye, 19½; potatoes, 39; clover, 39; green crops, &c., 39; and pulse, &c., followed by catch clover, 39 acres. I assume that it will take even an active cultivator four years to bring his grant under cultivation, and that he will break up a quarter section yearly. If his capital is scant he may be much longer, but of course the sooner he can get it under profitable yield the better. The tabular statement also shows the proposed preliminary cropping of the second and the third departments, until they respectively take permanent destination. In fixing

that preliminary cropping, my great object was to get the land well tilled, limed, and manured, and to exact from it, in return, as much as it can be made to yield towards the cost of bringing it into cultivation. The freshness of the land, and the fact that it is immediately to pass out of aration, concur in justifying heavy cropping for the short period prescribed for the preliminary process.

I shall now offer a few remarks on the crops which I have adopted as those of the Victorian course.

(1 and 5.) *Wheat* being, as I have before observed, the chief food of man, has assigned to it twice the area allotted to any other crop. I consider the arrangement of Providence by which land bears wheat willingly and remuneratively longer in succession than it is known to have done in regard to any other crop, very benign. Land has sickened of clover, grown shy of turnips, and refused to grow oats beyond a given repetition, but it has never yet shown any symptom of dislike to wheat; and though in the Norfolk course it has recurred every fourth year, approaching a century, and that too in turnip and barley soils, which are not the best for wheat, it is yet an acceptable crop to the land which has been under that course. My own English experience enables me to adduce the corroborative testimony of the parish under Jethro Tull's course for 130 years, to which I have adverted at the commencement of this essay, when calling attention to the churlish and impoverishing tendency of oats. Wheat has been found to respond so well to the application of lime, and to luxuriate so much in growth after its favorite preparative, clover, that it is universally allowed to be good husbandry to lime clover leys for wheat; and I shall therefore prescribe that practice in my course, in order that the wheat crop may be periodically fed with the aliment for which it has shown predilection; and I have also contrived so to place my catch crop of clover as that the wheat crop shall have the benefit of the extra humus which lime will manufacture from the roots and bottom-stems of the catch-clover, and the vegetable remains of the preceding pulse crop. Experience has also taught that beans, peas, lentils, vetches, and the pulse family generally, maize, millet, sorghum, (which is also of the millet family), gramme (which is also of the vetch family), buckwheat, hemp and flax, which, in my rotation,

accompany the pulse crops, are all friendly precursors of wheat; so that if manure proportioned to the exhaustion consequent on some of the supplemented cropping is applied with such of it as has an impoverishing tendency, I think the wheat crop will not be jeopardized by the extra duty imposed on the land by the introduction of the catch crop of clover.

(2.) *Potatoes*, being next in importance to wheat as the food of man, and especially important in a mining colony like Victoria, demanded an entire field in my course, to which I have assented, notwithstanding the known exhausting tendency of the crop, and the fact that it has not hitherto occupied so dignified a position in any English course considered orthodox. The extent to which potato cropping has been carried in Victoria for some years past, indicates the intention of the colonists to adopt it as a standard crop; and, looking to the requirements of a mining population, they are right. I assign to the potato crop the first preference share in the homestead manure of its year, for which it will yield good return. As the climate of Victoria has been found to ripen this crop at three periods of the year, that circumstance suggests the feasibility of double cropping the field in potato rotation between its wheat harvest and its barley seedness, a subject to which I shall afterwards revert when I discuss the question of double cropping.

(3.) *Barley and Rice.*—I am partial to a barley crop, and willingly allow it half a field in my course. It is liked by land, and is an orthodox crop on suitable soils in every popular course. It has the merit also of having stood the test of the Norfolk course, *sans* symptom of failure; and, as an Anglo-Australian population will always (despite temperance leagues) be malt and hop consumers, and as I have seen much first-class barley land in Victoria, I shall venture to predict, that if Sir John Barleycorn, Knight of the Southern Cross, has justice done him by Victorian brewers, "Bass's Straits ale" may peradventure in the sequel surpass in potency and renown the beverage of "Mister English Bass," famous as it is. The rustic proverb that "Barley likes a feather bed," is much to the point, and the crop following as it does in my course its favorite preparative, potatoes, will experience great benefit from the tilth demanded by that crop. It has frequently occurred to me that possibly the supposed non-adaptation of Australian soils to barley growing originated in the injudicious

attempts in the early days of Australian settlement to grow it on the stiff clays of Sydney localities, under the mere scratch surface operations then in vogue, which could only end in failure. I have seen splendid crops of first-class malting barley grown in Essex on strong soils of great tenacity, but the land was prepared for the crop by a previous summer fallow, to give it that feather bed tilth, without which barley cannot be successfully grown. Summer fallowing for the barley crop is a prominent feature in the agriculture of Essex, and is perhaps indispensable in the humid climate of England.

In regard to rice, to which I allot half a field, I am surprised that it has yet to be introduced into the colony; for, as a cereal, it is second only in importance to wheat. An attempt of Sir Joseph Banks, in 1798, to introduce its culture into England is recorded in the second volume of communications to the English Board of Agriculture. His attempt demonstrated that at all events as green food for cattle it was worthy of English culture. He states that he had not observed any corn tiller so much as his rice had done, for though at first it was thin on the ground, it soon became a dense, compact bed of plants, with blades in some of the kinds standing closer to each other than the thickest sown barley ever did. These at the close of August had become from a foot to eighteen inches high, and the plants still continued to tiller, each root having by that time produced from ten to twenty offsets, but no symptom of a rising stem was visible. In the middle of September they had still continued to tiller and to lengthen in blade, so that some were two feet long, but Sir Joseph having been taken ill, was obliged to desist from observing further progress. A frost soon after followed, which cut the blade down to the earth, and destroyed the hope of producing grain on that trial. His sowing was in the open air, and his seed was of several mountain varieties from India. Had he used seed somewhat acclimatised, and sown earlier, the result might have been more favorable as to grain. I have read that a field of rice was, under favorable circumstances, matured on the banks of the Thames near Windsor. The superior quality of rice grown in Carolina (where it was introduced incidentally) to that of the country which produced the seed, is an encouraging circumstance to Australian cultivators. As a variety sufficiently hardy for South Victoria, and to thrive without irrigation, would be a great blessing to the

colony, its introduction ought to be an object of early attempt. That which is successfully cultivated in Lombardy may surely (so far as climate is concerned) be expected to thrive in Victoria. In Java it is the regular practice to exact a green forage crop from rice before a grain crop, and why not in Victoria? A plant which tillers to the extent of from ten to twenty offsets, will be found an invaluable accession to the forage supply of the colony. There can be no question but that the super varieties of rice will succeed in North Victoria, and that in favorable localities irrigation may be applied to some extent. I may add that by simply reversing the ends of the field when it comes a second time in rotation, neither barley nor rice need be produced on the same land oftener than once in sixteen years.

As rice will be a new product in Victoria, I avail myself of the opportunity on revising for the press, to introduce the following quotation from Stuart's Travels in North America, in 1830: "Rice was first introduced into Carolina by a vessel from Madagascar, the master of which made a present of a small quantity to a gentleman in Charleston, who sowed it in his garden, where it grew luxuriantly. It was, in the beginning, raised on the uplands, where, however, it turned out that cotton was a more profitable crop; but the water culture of this grain, which was subsequently introduced, has rendered it a most valuable crop, both to the state and to individuals. No grain yields more abundantly. From 40 to 70 bushels an acre is an ordinary crop, but 80 and 90 bushels are often produced on such strong lands as have the advantage of being overflowed from a river or reservoir. The water is not let in upon the field until after the second hoeing, and it is kept on frequently for thirty days. Far more rice is produced in South Carolina than in any of the other states; but it is *a hardy plant*, and may be produced in any of the low lands, from the Mississipi to the Delaware."

I also adduce with satisfaction, the testimony of Dr. Mueller, that he found true rice, in a spontaneous state of growth, in the interior of Australia; which I consider encouraging both as to rice and cotton, because, the Doctor adds, that rice was usually concomitant, as a cultivated plant, with cotton.

(4.) *Clover* being the best known preparative for wheat, the best resting crop for land, and a meliorator of soil into the bargain, well deserves an entire field. The Norfolk practice of preferring cocksfoot grass (Dactylis Glomerata) to ordinary rye grass as an admixture with clover was an improvement on the older practice. The old annual variety of clover has certainly become a precarious crop on land which has often grown it, but the cause has not yet

been satisfactorily ascertained. Probably the best remedy will be found in a new variety. I apprehend that the hybrid species between Trifolium Pratense and Trifolium Repens, called Alsyke, will, if taken alternately with the annual red (or in tertial succession with the perennial red, called cowgrass, and the annual red), so lessen the evil as to make it of little consequence in Victoria where the land is all fresh. It is not unusual in Italian husbandry to make a clover crop respond thrice to the demand of the scythe, viz., an early spring mowing for soiling supply; a summer crop for store fodder, cut just before flowering; and then the seed crop; but some irrigation is required to effect so much. I shall afterwards revert to clover when I come to the pulse field.

(6.) *Green Crops, Bulbs, and Roots, &c.*—In the cropping of the potato field, and of this its companion field in rotation, I foresee great climate advantage to the Australian agriculturist; and I have a presentiment that winter will in the sequel become the Australian harvest season for turnips, cabbages, and the hardy brassicas, which, owing to the ravages of the aphis, have become too precarious for culture as summer crops. When Australian entomology shall have ascertained the degree of cold which these aphis pests cannot endure, we can balk them of their prey by timing successions of their dainties, when it will be death to them to feed, should they happen to be otherwise than inert at crop time. Swede turnips and yellow Aberdeens, and some other hardy turnips, and many British cabbages, and winter carrots, parsnips, British rape, and other hardy brassicas, and perhaps chicory, white mustard, kohl rabi, and some Scotch acclimatized beets, and other forage plants, will all respond to Australian winter culture, and yield crops sufficiently matured for soiling purpose, if not as store products. It will be desirable to keep as much of the summer season of this field as is practicable open for the cultivation of the sugar beet, which will probably become a staple product of South Victoria. There are other beets worthy of summer culture, as are also French and German cabbages, and many Spanish and Italian and other south European esculents, of which we as yet know but little. To what extent mangel-wurzel may by Scotch acclimating be made a winter product of Victoria, is a matter of great importance to the colony, and worthy of inductive investigation. Some summer turnips, carrots, parsnips, brassicas, &c., to keep up a succession of soiling food will be indispensable where a large dairy

is kept; for it is to be borne in mind that in Victoria the reverse of English practice will obtain, and the storing of cattle food will be for summer use, and not as in England, for winter supply, so that however desirable beet-sugar culture may be in South Victoria, its ground must be shared by the mangel-wurzel crop, if a sufficient supply cannot be grown in winter, because cows must have summer food. America will doubtless supply many edibles, both for the winter and the summer cropping of this field. I assign to this field the second preference share in the homestead manure for the year of its rotation. I have contented myself with mentioning such crops as occur to memory, as illustrating the scope which I think may be taken in the winter and summer cropping of this field, though I am aware many other plants can and ought to be included, when its cropping receives matured adjustment. Carrots which afford much hay fodder from their tops when dried do so well in Victoria as to be in my opinion one of the most important of our soiling plants, both for summer and winter growth.

(7.) *Oats* and *Rye*.—I assign half a field to an oat crop, because of colonial predilection for it as cereal hay, and because of its own intrinsic importance as a grain crop in a colony where many horses will always be kept. I may observe that, though I suspect that over oating will become a vulnerable point in Australian husbandry, I am individually endeavoring to avert such a sequence, for I only introduce the crop once in eight years, and by simply reversing the ends of the field when it comes a second time into this rotation, and making the oats follow the rye, and the rye follow the oats, the same land will only be called upon to produce oats once in sixteen years. A similar observation may be made in respect of the barley and rice field, and the field in rotation for pulse, &c.

Rye springs early, and has great merit as green food for sheep, and in soiling practice. It tillers much and responds well to repetition mowings, yielding greater bulk than oats. It is also of quicker growth, and will be found a reliable resource in dry seasons in aid of the pastures of the domain. The grain is extensively used on the Continent for distillation, and there is no reason why sterling Hollands shall not supersede the blue ruin stuff made from nobody knows what.

(8.) *Pulse*, &c., and *Maize*, &c., followed by catch clover.—

The haulm of pulse is such a favorite food of sheep, and the cropping is so genial to land and so necessary for many purposes, that its omission in a course of cropping would be an imperfection. I, therefore, assign half a field for the growth of beans, peas, gramme, vetches, lentils, and any other pulse found worthy of Victorian culture, and the other half of the field for the growth of maize, buckwheat, sorghum, hemp, flax, and the lesser millet, and any other products suitable for annual field culture, which may be thought desirable, and for which place has not been before assigned. Maize, millet, buckwheat, sorghum, and the vetch family have responded willingly to the yield of immature cropping as green forage, before the render of their main crops; but to what extent beans, peas, and lentils will do the like is a matter for ascertainment. This field is one of those as to which, by simply reversing the ends of the field when it offers itself a second time in rotation, the same land will not be called upon to produce like and like cropping oftener than once in sixteen years, which in some cases may be a great advantage.

The husbandry of Italy suggests a catch crop of clover as to both halves of this field, which I think worthy of introduction into Victorian practice. It is this. *Trifolium incarnatum*, a variety of clover of rapid growth, is sown in autumn, mixed with Italian rye grass, which is of like rapidity as to growth. The sowing is begun immediately after the preceding cereal crop has been harvested, and the clover is ready for cutting as green food in the following spring, a fortnight earlier than lucern, and is, therefore, the more valuable. Its adoption in my course, after the primal crops of this field, will have the effect of bringing the whole 78 acres coming into wheat rotation into a clover ley preparation for lime. Though I do not like the recurrence of clover so often as every fourth year, which is a result of this catch crop, I may state as favorable features in the case that all my clovers, and also their admixed grasses, may be of different varieties, and made to alternate in succession among themselves. The object is, however, very great; there being not only the value of the clover crop for consideration, but the great benefit of the clover ley preparation for wheat also.

Having broached the subject of *catch cropping* (as the practice of taking two crops from the same land in a given period has been aptly called), and having got through the cropping of my chief

course, I shall now make a few observations on a subject which I consider fraught with great good or with great evil, as it is used with judgment, or abused by injudicious management. If catch croppings are allowed to jeopardize main crops, or if great produce is exacted from the land without due replenish by manure, and so as to incapacitate it for its routine duty, the evil may be greater than the good, and incalculable mischief may ensue. Unquestionably the climate of Australia gives great facilities for catch cropping, and for repetition mowings and grazings of the cereals, and I am inclined to estimate Australian sunshine at a high rate in connection with its husbandry. I observed it stated in the report to which I have adverted, that potatoes, turnips, sorghum, and mangel-wurzel had all been taken as second crops either after oaten hay, or barley cut in the spring for green fodder; that barley had been succeeded in the same year by sixty days maize; that peas, vetches, and potatoes had yielded crops at three periods of the year (I suppose an early crop, a main crop, and a late crop); and that potatoes after barley of the same year might be depended upon. Other instances will, no doubt, occur as colonial culture progresses, but those already stated are very encouraging, and indicate great capabilities both as to climate and soil. They also suggest great scope both in crop rotation and catch cropping.

In regard to the potato field, it is my opinion that if British rape is sown immediately after wheat harvest on that part of the field which is destined to produce the third division of the potato crop, it will supply much soiling food up to a late period in spring, when it may be allowed to run up into seed, which will have time to ripen before the land will be wanted for the last division of the potato crop. I mention British rape in preference to the cole variety of the Continent, because I happen to have seen much of its culture, and think it likely, from its habitat, to be the hardier variety of the two; but I should advise the introduction of both varieties, in order that their comparative merits may be tested both as to cattle food and oil. I give to the rape crop the last potato land purposely for the production of oil. I have seen farm-made rape cake of good quality, and if the Victorian agriculturist shall not, for want of machinery, be able to make the best of his oil he may, by mixing it with proper substances, increase the quantity of of his cake, and convert it advantageously into beef and mutton. Winter beet and mangel-wurzel may be taken from that part of

the potato field which is intended for the first division of the potato crop, because (even if immature and not of great weight) they will come in opportunely for the dairy cows; and the bulk of the field intended for the main crop of potatoes may be planted with hardy British cabbages of many varieties, to keep up a constant succession of fusiform rooted brassica food, until the ground must be cleared for potatoes. If this brassica and beet catch crop is taken, it ought to have a liberal allowance of guano. By planting the brassicas, rape and beet, in drills crosswise of the field, and the potatoes lengthwise, both crops will to a great extent have fresh land.

Half the winter crop of the companion field to that in potatoes is intended to be Swede turnips and yellow Aberdeens, or other hardy turnips; also hardy carrots, parsnips, chicory, white mustard, and colza, followed by sugar beet as the summer crop of that half. The other half of the winter crop is intended to be Scotch acclimatised mangel-wurzel, followed by summer turnips, carrots, parsnips, and chicory, and by yams, onions, Strasburgh and French cabbages, and by warm climate bulbs, roots, tubers, and plants admitting of annual field culture, which may, on trial, be found worthy of reception into the Victorian course of cropping. Guano will be found to be an eligible manure for the winter cropping of this field, because, as a stimulant, it will invigorate vegetation in the winter, and the rain will well diffuse its fertilizing properties in the soil.

My leading eight years' course is avowedly for land of first-class staple only, be that land limestone formation, or of volcanic origin, or a well proportioned admixture of clay and sand, known as a clayey loam; and though the development of that course was the leading aim of my essay, I shall prescribe the following rotations for land less favorably circumstanced as to staple, making use of well understood though untechnical terms:—

For an eight years' course on land of a loose texture, and of insufficient staple for the leading course, I would suggest—1, oats; 2, potatoes; 3, rye; 4, clover; 5, wheat; 6, green crops and roots, and especially the Jerusalem artichoke; 7, millet, lentils, and vetches in equal proportions; and 8, buckwheat, with vetches on the land after millet; and then oats again, and on in repetition course; liming the clover ley for wheat, and manuring heavily

with homestead dung for the potato crop and the green crops, but adhering in this course to single cropping, because such land will not sustain catch cropping.

For an eight years' course on a light loam (such, for instance, as is known in England as a turnip and barley soil) I would suggest —1, oats and rye; 2, clover; 3, wheat; 4, potatoes; 5, barley and rice; 6, peas, vetches, gramme, and catch clover; 7, wheat; and 8, turnips, mangel-wurzel, beet, cabbages, roots, and green crops, but adhering in this course also to single cropping, save as to the catch clover.

For an eight years' course on a strong clay soil approaching to stiffness, I would suggest—1, oats; 2, clover; 3, wheat; 4, Swedes, mangel-wurzel, and potatoes; 5, barley; 6, beans, vetches, maize, and sorghum; 7, wheat; and 8, rape and cabbages, &c.

I now approach the very important question of *repetition grazings and mowings of the cereals* as green crops and fodder, before they are called upon to yield grain. That the cereals possess vitality beyond most other plants, and exert an inherent power to repair damage by frost or accident, by a process called tillering, has been long known, but the systematic application of that power to profit in a cropping routine has yet to be made, and probably Victoria will initiate the practice of subjecting this process to inductive sway.

British husbandmen were probably the first to notice the beneficial exercise of the tillering process. The wireworm grub, by eating through the newly-germinated stem of wheat, did incalculable mischief, and when the germ was eaten close off the plant perished; but if a particle of it was left the inherent power to tiller, though previously inert, sent forth shoots which became stems to the original root, and produced many ears of wheat instead of one. Pursuing this hint of nature, an intelligent farmer, who happened to have a thinly-sown crop, eat it down with sheep, to induce a tiller to thicken his crop; and this being successful, it became a practice, whenever the saving of seed was an object, to sow thin, and draw upon the plants for seed deficiency by a tiller. Circumstances, however, which have prevented the British farmer making much of the tillering property, and of cereal vitality, do not obtain in Australia; but the very

converse is the case. The British climate is moist, the season is generally wet, and when it does happen to be dry and favorable at the time of depasturing the grain crop, the farmer dare not linger in the field for the sake of the food, but draws his flock off as soon as his one object has been accomplished, lest a stern British winter should overtake him before his grain is ripe. Now, the Australian cultivator, having abundance of dry weather for depasturing his cereals, may make them regular sheep pastures, if he chooses that course; or he may mow them periodically for soiling supply, if that answers his purpose better; and having no dread of a British winter, he can calculate the sunshine he will want to flower, seed, and ripen his grain; and can induce the flowering process just when he wants it to ensure the clearing of the ground for the crop next in succession.

Up to the stage next precedent to that of flowering, the stem and leaf, or blade-producing powers of a plant, are those which govern its existence and impel it onwards to seed. If the blade of a cereal is damaged or destroyed, it is re-produced, perhaps stronger than before; and the only consequence is delay in the progress of the plant towards seeding. If the land is in heart, and the plant is healthy, repetition grazings and mowings will exact a great amount of stem and leaf, or blade produce, before it need be allowed to push into flower. It is critical to deal with a plant in flower, and destruction to it to interfere in a seeding state, for the moment the seeding power is called into operation, the stem, leaf, and flower-producing functions all merge in that of the seed-power, which thenceforward becomes the governing power of the plant. The exact point, either before or in the flowering stage, at which cereals may be mown, with a certainty of reproduction, is so important to the husbandry of Australia that it ought to be an early subject of accurate investigation, it being certain on the one hand that the more fodder is matured, before it is cut, the greater is its value; and, on the other, that the grain is jeopardised if a fodder crop is taken a day later than nature warrants. In a colony yet devoid of perennial pastures and meadows, it is very important to be able to make the best of the cereal supply, and to fix with certainty not only the precise time of severance, but the number of mowings to which a crop will profitably submit; for, if the older colonists are right in their supposition that, as a general rule, the cereal supply is to be the

reliable resource of the colony for hay fodder, the enquiry assumes the greater consequence; and it may be well to extend it to sorghum, buckwheat, maize, the lesser millet, vetches, rape, and all other plants from which it is intended to exact immature contributions towards soiling supply; and to ascertain also the extent to which the beets, and other similar plants, will submit to be despoiled of their leaves without injury to their more important products. All the cereals (unless rice shall prove an exception) will admit of autumnal sowing in Australia, and of growth during its winter, so as to yield an immature scythe contribution to the soiling department in early spring.

Theorists reputed sound have stated that crops fed off in a green state, or mown before the seed was formed, might be repeated time after time, and kind after kind, with safety; it being only (as they state) in responding to the production of seed that soil is impoverishingly drawn upon: and it has, in consequence of that statement, been inferred, that when cereals are mown for hay before seeding, they take but little out of land. My impression is, that that conclusion has been pushed too far, and that the effect of the impulsive effort of germination on the land, has not been sufficiently estimated.

The seeds of most plants have a structure from which one stem only can proceed, but the cereals which yield human food benevolently depart from that structure. In them the embryo plant is so organised as that many stems spring from one grain. That departure is the origin of the tillering process to which I have adverted, and its importance in a climate in which full advantage can be taken of such a benignant provision, is my motive for giving it such a distinctive notice in this essay. It will be a singular coincidence if the oft quoted observation of Swift, in his Gulliver's Travels (which, bye-the-bye, was a theft of Swift's from Rabelais), "that the man who caused two stalks of corn, or two piles of grass, to grow where only one grew before, is a greater benefactor to mankind than all the philosophers, poets, orators, and politicians, that ever existed," shall be first systematically acted upon in the husbandry of Gulliver's own country (for beyond question Capt. William Dampier was the Lemuel Gulliver of Swift); and that it shall be applied to the extent of taking three croppings from the cereals instead of one—viz., a grazing of the blade crop by sheep to induce a tiller; a mowing

of the succession shoot, as green forage for soiling supply, or as dried fodder; and in the sequel—the grain crop itself.

I have before stated that the Javanese exact a cereal fodder yield from rice, as well as a grain crop; and I think it important to save land from the tantalization of several impulsive germinating efforts, where one may suffice. The saving of the seed and labor of several sowings for an object which one sowing will effect, is also a consideration.

On revising for the press I have to add that the fact that the cereals are to some extent biennials upholds my conclusion as to their ability to respond to repetition croppings, and I am glad to be able to adduce confirmation of that conclusion. Lawrence, in his Farmers' Kalendar, the third edition of which was published in 1801, writes thus :—" Upon soils, where wheat is apt to grow rank or winter proud, it is the custom to feed it down in the spring with sheep, and in some parts of Kent and elsewhere, even with bullocks and horses, up to the month of May." "Wheat, prevented by grazing from growing to seed, becomes to some extent perennial, and endures as grass. It remains to be determined, by experiment, to what degree it is advantageous to grow wheat, barley, and oats as soiling food, or as hay for cattle ; at any rate the nutritious and fattening quality of such provender cannot be questioned." But W. P. Taunton, Esq., in his prize essay on rye, published in the seventh volume of the Journal of the Royal Agricultural Society of England, carries the matter much further than Lawrence, and thus writes :—"I have known an excellent farmer, who had abundance of manure from a fully stocked yard and stable, to mow his wheat crop for stable food currently twice, and in one instance thrice, in the summer, and afterwards to ripen a crop of the grain of wheat in each case ; in many instances a good crop ; but his fields were like a hot bed, and if he had not mown them the wheat would have lodged and rotted on the ground. Wheat is in truth the most nutritive and the most productive, though not the earliest, of all the soiling crops ; and those few fortunate persons who complain that their land is too rich for wheat would, if they were to cultivate wheat thereon as a soiling crop, enjoy a most abundant and profitable return therefrom." "The beautiful variety of barley, called *hordeum bulbosum*, has been found when in flower to raise its second crop of culms to perfection in the same summer."

Though I do not subscribe, without reservation, to the dictum of Olivier (a member of the French Institute), that the intervention of beans, or of turnips, and such crops after wheat or oats, &c., is certain and complete destruction to the Tipulae, Muscae, and other insects which prey upon the roots of the cereals, because I know of too many instances in which tenacious vitality carried both insects and larvæ existingly through adverse alternation in cropping ; I am, nevertheless, willing to admit that a systematic alternation which limits cereal cropping to a single year, and

prohibits even a kindred crop in succession, is likely to keep them much under, and that therefore to that extent alternate husbandry is decidedly beneficial as a counteracting agency both against insect rapacity and vegetable malady.

The following quotation from an essay by Lawes, an agricultural chemist, published in the Journal of the Royal Agricultural Society of England, well justifies the importanee which I have given to wheat and to the other cereals in my Victorian course of cropping :—"The climate of Australia combines in an eminent degree the small amount of rain and the high temperature necessary for the perfect development of corn, and the wheats imported from that island obtain a price in the market very much beyond those of English growth."

The colony of South Australia deserves the grateful remembrance of all the Australian colonies for its masterly representation of the whole at the great English Industrial Exhibition of 1851. I devoted a day to the examination of Australian exhibits, and chuckled at my anticipated connection with a region which could produce wheat weighing as was stated 70 lbs. to the bushel ; and being, after a residence of two years in Victoria, certain that all the cereals will become its staple products, and that the soil of Victoria will enable its colonists to compete—as to wheat with South Australia, as to rice with Carolina, and as to barley with England, I cannot but regret that Victoria has not by forethought provided champion samples of all the cereals for the forthcoming English Exhibition, and that such an eligible opportunity for announcing to the civilized world the great cereal capabilities of the colony should have been thoughtlessly lost.

The second, or grass land, and live stock department of Australian husbandry, admits also of systematic management, and may be worked harmoniously and well, in conjunction with the arable land, as I will show. I shall arrange the various objects of Australian animal and zoological husbandry care into twelve classes, and briefly treat of each ; premising that, according to the statistics to which I have before adverted, the live stock of the colony numbered, on the 31st March, 1859, 5,578,413 sheep ; 699,330 cattle ; 68,323 horses ; and 37,756 pigs. Poultry and the minor quadrupeds are not stated. Over five millions of the sheep belonged to squatting stations, and that circumstance shows the extent to which the pastoral interest of the colony has developed itself.

I have assigned to the live stock department the eleven fields before mentioned, of which the two cow pastures together contain 52 acres ; the two sheep pastures, 26 acres ; the two general pastures, 26 acres ; the two hospital crofts, 13 acres ; the permanent clover pasture, 13 acres ; the lucern pasture, 13 acres ;

and the water meadow, 26 acres. In all 169 acres, in addition to the yield of the arable department, in the way of cereal herbage, green forage, and hay; and to the render of the two green crop and root fields, and of the two clover fields; supplemented by the straw and haulm of the grain and pulse crops: and when it is considered that Sir John Sinclair estimates the straw yield of an average British crop of wheat at 30 cwt. to the acre, of rye also at 30 cwt., of oats at 25 cwt., and of barley at 20 cwt.; and that on the data of Sir Joseph Banks, it may be safely assumed that rice straw would at least equal that of wheat, it will be apparent that under soiling management, a large dairy and a goodly number of breeding ewes and fatting sheep, may be kept on agraria domain, and that its homestead manure will be considerable.

Sheep constitute my first class of the animals of Australian care. The annals of husbandry do not disclose any circumstance so astonishingly interesting and successful as the shepherding of Australia. That sagacious colonist of the mother colony, John McArthur, having observed the effect of the Australian climate, in improving the wool of the then mongrel sheep of New South Wales, became an Australian benefactor to an incalculable extent, by his introduction of the best woolled breed of sheep then known. He was probably not aware that his pet *Merino sheep* were descended from English flocks, which, in the days of the Plantagenets, fed on the green but bleak Cotswold pastures of England, and were then doubtless clad in the dreadnought fleeces required for a British clime; but which, in consequence of amalgamation with Spanish flocks, and the basking for three centuries in the sunny pastures of Spain, resulted in the establishment of the merino breed, predestined to produce a marvellous Australian result.

Low, in his work on the Domestic Animals of Britain, questions the English origin of the Merino breed; but I think it very satisfactorily evidenced, and will introduce a few remarks on that head in support of my view.

In Knight's Pictorial History of England (vol. 2, p. 190), I find it stated that "in 1438 a license was granted by Henry VI. to a Portuguese agent in England, for leave to export to Florence sixty sacks of *Coteswold wool*, to be worked up in clothes of gold

and silver for the King of Portugal," and that Edward IV. was said to have presented King John, of Arragon, with several English ewes and rams; and Knight refers to Tusser and other authorities quoted by Anderson in his History of Commerce in support of his statements. It unluckily happens that my copies of Anderson and Tusser have not yet arrived, and that there is no copy of Anderson in the Public Library of Melbourne, so that I cannot at present pursue the matter further than Low himself carries it in the following quotations, which I make from his own work. "In those Wolds (Cotswolds), says the translator of Camden, they feed great numbers of flocks of sheep whose wool, being most fine and soft, is held in passing great account amongst all nations." "Stow writes that in 1464 King Edward IV. concluded an amnesty and league with King Henry, of Castill, and King John, of Arragon, at the concluding whereof he granted license for certain *Cotswold sheep* to be transported into the country of Spain, which have there since mightily increased and multiplied, to the Spanish profit, as it is said." And, in another part of Low's work he says, "it has been the opinion of many that the Merino sheep of Spain have been derived from England." "Baker, in his Chronicle, says, King Edward IV. entered into a league with King John, of Arragon, to whom he sent over a *score of Cotsal ewes and four rams*." "From this slender incident it were *idle* (says Low), to infer that the modern Merino owes its origin to the sheep of England, though certainly the resemblance of the Dorset breed of England, and particularly of the variety termed the *Pink-nosed Somerset*, would seem to be sufficiently striking to give some countenance to the supposition."

With due deference to Low, I think he does injustice to his own premises by his *idle* deduction from his own quoted authorities. The twenty ewes, which would probably yield an average of ten pure English-bred rams yearly, or in that proportion, as long as any of them were kept aided by the *four rams* which were sent, on this true Jasonic expedition of the Golden Fleece were, in my opinion, more than sufficient to produce in three centuries, by the crossing of large Spanish flocks and the progressive ratio of in and in breeding—the Merino breed as it stood in 1764—when it first began to be much noticed.

That Spain, as well as England, had, anterior to 1464, a fine-wooled breed of sheep, is clear; and Spain has yet other varieties

of sheep which are fine-wooled, but lack the brand of the "Pink-nosed Somersets" with which the four Cotswold Jasons and their youngster kin stamped their progeny by the Spanish ewes.

The Cotswolds of 1464 appear to have been a different race from the oldest of two breeds now known by that name, which appears to have supplanted the finer-wooled flocks early in the last century. Low surmises, and I think rightly, that the first Cotswolds were of the Ryeland family, and supports his view by a quotation from Speed, who wrote in 1629. "In Herefordshire, especially about Lempster, and on those famous hills called Cotswolds, sheep are fed that produce a singular good wool, which, for fineness, comes very near to that of Spain, for from it a thread may be drawn as fine as silk."

Low appears to think that the Spanish Merino owed something to an earlier (African) cross, which I think probable. His suggestion that the oily secretion of the skin which characterizes the breed is of African origin, is worthy of consideration, and I therefore call attention to it as a hint in what direction an Australian Bakewell is to look for that property when he wants to clothe a new Leicester carcass with a Merino fleece, which would, in my opinion, be the best Australian alliance between wool and mutton.

"Several of our annalists," says John James in his History of the worsted manufacture of England, published in 1857, "have narrated that in the reign of Edward the Third, and again in that of Edward the Fourth, a number of English sheep were, as a great boon, allowed to be transported to Spain to improve the Spanish breed, thus denoting that the English wool was then superior to the Spanish. Very conclusive confirmation on this point is given by Capmany (in his '*Memorias Historicas sobre la Marina, commerci y artes de la antigua ciudad de Barcelona*,' of which an edition was printed in 1779,) in a number of laws drawn up in the year 1438, by the municipal authorities of Barcelona, for regulating the manufacture of cloth from fine English wool (*lanes fines de anglaterra*)."

In another part of his work Mr. James says, "Proof may be adduced that from a very early period *English wool was deemed to be superior to Spanish.* In the confirmation by Henry the Second to the weavers of London of their guild, it was directed that if any weaver mixed Spanish wool with English in making cloth it should be burnt, plainly implying that the English wool was of superior quality. *It seems probable that, after the time of Edward the Third, the fleece of Spanish sheep had improved, in consequence of a number of English sheep being permitted by that monarch to be exported to Spain.* From Capmany's History of Barcelona it appears that about this period English wool was sometimes sent to that city to be manufactured into the finest

cloth then produced. Spain and England were, in this age, the only wool growing countries in the world, but that produced by the former consisted of an inferior staple, altogether unfitted in itself to make the delicate and superior fabrics of Flanders."

With that triumphant demonstration of the *idleness* of Low's insinuation to the contrary, I shall pass on to the observation that the Australian climate will co-operate with judicious crossing in effecting improvement in Austral-Merino wool, and that if no Merino rams are used but those which have pretensions to symmetry, combined with fleece-character, and aptitude to fatten, Australian-bred Merinos will soon approximate to a great degree of perfection, both in wool and mutton.

It is matter of surprise, from what small and recent beginnings, amazing results have proceeded. Bakewell, who fashioned the new Leicester breed on an ideal standard as to perfection of his own, and created a new era in shepherding, only began his practice in 1755. His first ram lettings in 1760 only averaged seventeen shillings and six pence each, and for some years his general price was a guinea; but in 1785 his price had risen to one hundred guineas for his best rams, and in 1789 he made six thousand two hundred guineas by his ram lettings, a practice which he originated, and for which he was laughed at as a foolish innovation. It is to be regretted that he (avowedly) paid no attention whatever to wool, and thought only of the butcher, though his disciples have improved in that respect.

Ellman, the great improver of the South Down breed, only began his improvements in 1780. He, however, wisely attended to wool as well as mutton, and chalked out a path in which the shepherd princes of Australia ought to tread; and MacArthur demonstrated, by what he effected for the Austral Merino breed within living memory, that "the four Cotswold rams, and twenty Cotswold ewes," were amply sufficient to produce (by crossing the Anglo-Spanish flocks pre-existing there), the Anglo-Spanish Merino breed extensive as it has in the course of four centuries become.

On revising for the press, in June, 1861, I avail myself of the opportunity thus afforded to amplify my original outline of this branch of my subject into the more finished sketch which I now present; and I do that the more readily because it is now apparent that long-wooled sheep, as well as the Merinos and the other fine-wooled varieties, are henceforth to be objects of

Australian care. I have also—under the impression that the Dishley blood will be predominant in all the long-wooled and medium-wooled sheep which will be imported from England—endeavored to unravel the mystery in which Bakewell sought to envelope the origin of his breed, in order that Australian breeders may have a criterion for judging to what extent Bakewell's blood, or the blood of any cognate source, already pre-exists in any sheep intended to be the subject of inductive experiment.

From the days of the patriarch Jacob, who outwitted Laban in the cunning bargain as to the marked animals, down to those of Robert Bakewell, it appears to have been a recognised point in breeding that understood causes were productive of given results, and that like produces like. Bakewell, however, appears to have been the first known individual to whom nature revealed her secret of moulding an animal to a given make, and of perpetuating that make, with its newly combined properties, in the descendants of the animals so moulded He operated not only upon sheep, but also upon neat cattle, horses, and swine; but his greatest success was in what is now properly called *the Dishley breed of sheep*—occasionally, however, yet known by its original name of the new Leicester breed. I have here to remark that Lincoln and Leicester, being adjoining counties, had in common, at the commencement of the eighteenth century, a breed of large sheep, which appears to have had a Lincolnshire origin; though, in loose nomenclature, it was by some authorities occasionally called the old Leicester breed. The consanguinity of the old Leicesters with the old Lincolns, and the better claim of the pastures of Lincolnshire to the distinction of having fed up the breed to its great development in size and in wool, is, however, now generally admitted. Bakewell inherited, with the lease of Dishley Farm, which happens to be located on the Lincolnshire side of the county of Leicester, his father's flock of sheep, in which, all authorities agree, the old Lincoln type was predominant, and it is also agreed that that flock was the nucleus of the Dishley breed. It is, however, to be regretted that the selfish policy of Bakewell led him to mystify the origin of his breed, and to conceal from his contemporaries, and from posterity, the sources of his own success; a mistaken course, in which his memory received, in its passage to posterity, that ring-straken brand which has marred his title to be considered as a benefactor to the agricultural community. It luckily happens, however, that the source of the Dishley blood is trackable, despite the selfishness of Bakewell, as I will endeavor to show. Arthur Young, who called at Dishley when he made his Farmer's Tour through the east of England, in 1770, writes thus in his Tour:—"In the breed of his sheep Mr. Bakewell is as curious, and I think, if any difference, with greater success than in his horned cattle."—"*The breed is originally Lincolnshire; but Mr. Bakewell thinks, and very justly, that he has much improved it.* The grand profit is from the same food going so much further in feeding those than any others. Not, however, that Mr. Bakewell's breed is small; on the contrary, it is as weighty as nine-tenths of the kingdom; for he sells fat wethers at three years and a half old, at two pounds a head. He sells no tups, but lets them, at from five guineas to thirty guineas for the season."

The following is the measurement, in the wool, of a three year old ram,

stated, in Young's Tour, to have been measured on the 17th March, 1770. which I transcribe, in order to convey a notion of the size to which Bakewell had then reduced his sheep :—

	Ft.	ins.
His girt	5	10
His height	2	5
His breadth of collar	1	4
His breadth over his shoulders ...	1	11½
His breadth over his ribs	1	10½
The breadth of his hips	1	9½

Young's visit was so opportune, and his words are so explicit, that (referring, as they do to the period when Bakewell, after fifteen years of inductive experiment, had finally modelled the breed to his mind, and was known to be breeding in and in) they have always, to my mind, been conclusive as to the Lincoln lineage of the Dishley breed, notwithstanding Bakewell's insinuations to the contrary in some of the controversies in which his want of candor involved him. My father, who was brought up a farmer, adhering to the dictum of his father—who had been a Teeswater breeder—always spoke of the Dishley sheep as Lincolns, dwarfed, and made symmetrical, by a white fine-wooled cross. What that cross was shall now be the subject of discussion.

The wool of the Dishley breed is evidently a blend of a short-wooled with a long-wooled fleece, and nature's brand to that purport will probably be among early revelations of the microscope, now that it is being applied to matters connected with wool Leicestershire tradition—which I gathered when I went on pilgrimage to Dishley many years ago—states that the Ryeland breed contributed the short-wool ingredient to the blend, along with the fineness in bone and aptitude to thrive on scant fare, which were Bakewell's chief aims in that cross ; it being to be observed that, long before his time, the Ryeland breed had acquired the repute of possessing, pre-eminently, symmetry, with predisposition to fatten, and also fineness in bone, which were Bakewell's favorite qualities. Tradition also states that he bred occasionally from Dorset ewes, and had a liking for that blood; perhaps, therefore, it may be assumed that the short-wooled ingredient in the Dishley blend was a compound of the Ryeland and the Dorset, in proportions within the powers of the microscope to reveal ; and if my surmise is well grounded, the microscope may be the key which, when applied to nature's brand-mark on a Dishley fleece, will unlock Bakewell's arcanum, and let out his long-kept secret, which peradventure, after all, when known, will amount to no more than this—that, in 1770, when he had adjusted his Dishley blood, it had in it 60 per cent. of old Lincoln, 30 per cent. of mixed Ryeland and Dorset, and the remaining 10 per cent. of various breeds, intermingled for special mutton points. It is because the Dishley blood has since become so diffused, that scarcely any English flock of note is now without it, that I have deemed it worth while to pursue this investigation to the extent which I have.

William Marshall, an acute observer, who resided four years near Dishley

Farm, and had several interviews with Bakewell, at Dishley, thus writes in his Rural Economy of the Midland Counties, published in 1790:—"The manner in which Mr. Bakewell raised his sheep to the degree of celebrity in which they deservedly stand is, notwithstanding the recentness of the improvement, and its being done in the day of thousands now living, a thing in dispute, even among men high in the profession, and living in the very district in which the improvement has been carried on. Some are of opinion that he effected it by a cross with the Wiltshire breed; an improbable idea, as their form altogether contradicts it. *Others that the Ryeland breed were used in this purpose; and with some show of probability. If any cross whatever was used, the Ryeland breed—whether we view the form, the size, the wool, the flesh, or the fatting quality—is the most probable instrument of improvement.*"—"*The wool is shorter than long wools in general, but much longer than the middle wools, the ordinary length of staple being 5 to 7 inches, and varying much in fineness and weight.*"—"The origin of letting rams by the season, in the midland district, may be traced to a ram let by Mr. Bakewell, at a Leicester fair, about forty years ago, at the low price of sixteen shillings, and his letting two more, on the same day, at seventeen shillings and sixpence each; and humble as was this beginning, it proved to be the first stone of the foundation of a department of rural business that has already risen to an astonishing height, and may for some length of time continue to bring in a copious source of wealth to the country."—"Mr. Bakewell this year (1789) makes, I understand, twelve hundred guineas by three rams—brothers, I believe."

The importance of sheep in Australian husbandry, and my wish at this early stage of that husbandry in Victoria, to manifest the title of England to copartnery with Spain in the honor of having formed the Anglo-Spanish Merino breed, which Providence appears to have predestined to be the leading breed of Australia, and the urgency of the growing demand of England for longer wool, and of a Victorian mining population for larger and better mutton, has led me into details as to the blood of the two most remarkable varieties of sheep, *of known origin*, as yet produced, viz., the *Merino, formed with the avowed object of producing fine wool*, without much care as to mutton (for the Merino monopoly remains to this day, in Spanish policy, the mere wool guild which it was when the Anglo-Merino breed was formed by the Anglo-Spanish cross); and the *Dishley, formed expressly for mutton*—(for Bakewell is recorded to have said "that wool was no object with him; and that he did not care whether his sheep carried fleeces or not, for that one thing only was wanting to ensure him an ample fortune—the discovery of a breed of sheep without wool") As my object is that of presenting systematic and scientific views to Australian shepherds as well as to wool as to mutton, it is, I trust, somewhat more rational than Bakewell's anti-wool crotchet.

Ellman, as I have before observed, aimed, in his celebrated *South Down breed*, at a combination of wool and mutton; but as mutton will always be the predominating object with the British shepherd, whilst wool, on the contrary, ought to be the paramount object in Australian shepherding; and as I think it incumbent on Australians to form breeds expressly adapted

for their own husbandry, I shall introduce to their notice four particular breeds, viz., the "Old Lincoln," and the "Ancient Teeswater," longwools, and the "Dorset," and the "Ryeland," shortwools, as deserving of especial attention in any endeavor to attain excellence in the production of both kinds of wool, and of improvement in mutton.

The "Old Lincoln" and the ancient "Teeswater" breeds, being the giant families of the Ovis race, demand as such especial Australian notice. The following quotations from Arthur Young's View of the Agriculture of Lincolnshire, published by the English Board of Agriculture in 1808, will bring Australians acquainted with two ancient sheep of the *Old Lincoln breed*:—"Mr. Graves, of Spalding, had a true old Lincoln sheep, that clipped the first year 23 lbs. of wool, and the second year 22½ lbs. It was sold at Smithfield, at Christmas, and weighed 40 lbs. a quarter. Of this sheep Mr Bakewell said that he ate as much as three ; but that was mere assertion," "Mr. Trimmell, of Bicker, near Boston, killed a wether, of 67 lbs. a quarter at four years old. He never ate any corn, oil cake, &c, but fed wholly upon grass and herbage. Being turned with many other sheep into a field of clover, it was observed to search for all the sow-thistles, and would eat no other food whilst any of them could be found ; and when the field became bare of food the shepherd, guided by the sheep's propensity for sow-thistles, gathered a quantity for him at stated hours, three times a day, from 2 lbs. to 5 lbs. at a meal. Standing on his feet, he measured only 2 feet 6 inches high, and weighed, alive, 26 stone, of 14 lbs. ; he gained only 1 lb. the last month, and then, thinking he had got to the top and quite ripe, he was killed on the 13th October, 1791, being then a four shear sheep. The skin, hung up by the nose, measured 10 feet 2 inches, from the point of the nose to the tip of the tail, and was sold for seven shillings and sixpence in the common course of business. The carcass measured five feet from the nose to the tail ; its rump or cushion, eight inches and a half in depth ; plate or fore flank, the same thickness ; breast end, seven inches ; one yard five inches and a half round the collar ; and weighed 67 lbs. a quarter. The legs, cut haunch or venison fashion, weighed 50 lbs. each, which the butcher sold at two shillings a pound, so that the two legs brought ten pounds." Young does not give the weight of his fleece.

The following quotations from the more recent report on the farming of Lincolnshire, published in the journal of the Royal Agricultural Society of England, will give a notion of Lincolnshire sheep farming in 1851, when the Old Lincolns had, in great measure by crossing, merged in improved breeds of inferior size :—"The larger breeds chiefly occupy the south-eastern quarter of the county, and are known as 'the Lincolnshire long wools,' in contra-distinction to the Cotswold and improved Oxfordshire breeds. They partake largely of the peculiarities of both Cotswold and Leicester, having the expansion of frame and nobility of appearance of the one, combined, in a great degree, with the quality of flesh, compactness of form, beauty of countenance, lightness of offal, and inclination to fatten, of the other ; but they far exceed either in the weight of their wool. They are usually kept until 27 to 33 months old, when their weight is from 28 lbs to 72 lbs. per quarter ; and the two clips of wool weigh together

about 20 to 25 lbs. Under good management this wool is of a quality which rarely fails of obtaining a price equal to that of the lighter long wools, or even pure Leicesters (*i. e.* Dishleys) ; and there is, therefore, perhaps no breed that can equal this in rapidity of growth, and propensity to fatten, under a fleece so weighty and valuable. Some instances of extraordinary weight may be stated : a wether sheep, killed in Holbeach Marsh, in 1844, weighed 72½ lbs. per quarter. Ten wethers were produced by one farmer, in the same locality and at the same time, averaging upwards of 52 lbs. per quarter each ; and a ewe, from Long Sutton Marsh, exhibited at the Smithfield Club cattle show in 1846, weighed, when dead, 65½ lbs. per quarter, or 262 lbs. the whole carcass. In the midland and south-western parts of Lincolnshire, the sheep are more closely allied to the true bred Leicesters (Dishley's), the proportion of blood being estimated at three parts Leicester to one of Old Lincoln, and are very compact and well formed, with fine and good countenances, and rather close set but beautiful wool. They can be generally fed off, at the age of 18 to 27 months, and are noted for their large proportion of lean meat ; if kept longer, it is for the purpose of taking the fleece ; the two fleeces weighing together about 17 lbs., and the carcass about 35 lbs. per quarter on an average. A breeder in the neighborhood of Grantham showed a shearling sheep of this class, which clipped 17 lbs. of wool, and weighed 22 stone ; being one out of an even lot of 27. In the northern, and north-eastern parts of the county, about one-fifth of the sheep are pure Leicesters, and the remaining four-fifths are descended from the original large Lincolnshire sheep, crossed latterly with Leicester rams ; being thus neither too coarse nor too delicate, uniting size with quality, and having heavier fleeces, though of coarser quality, than those of the unmixed Leicesters."

The ancient Teeswater breed has passed by metamorphose into the modern Cotswolds, and its kindred breed, the improved Oxfords; and a noble breed, both for wool and mutton, *the modern Cotswold* has in consequence become. It was long a moot point, whether the old Lincoln and the ancient Teeswater were not of kindred blood : my father, who was born on the banks of the Tees, and whose father had been also born there, thought not ; and William Marshall, who was also a native of Yorkshire, and my father's senior by twenty years, appears to have been of the same opinion, for he thus writes in his Rural Economy of Yorkshire, published in 1788 :—" The improvement (in the sheep of the vale of York) has been effected by the introduction of rams of the Leicestershire and the Teeswater breeds ; the former hired of Mr. Culley (a spirited and successful disciple of Mr. Bakewell), and the latter of Mr. Colling, and other attentive breeders in the neighborhood of Darlington, on the banks of the Tees. Fortunately, perhaps for the Vale, two of its most considerable farmers, to whom it is principally indebted for its present improved breeds of stock, differ in their opinions respecting the superior excellency of these two breeds of sheep, each of them propagating and encouraging his own favorite breed. Both of them are excellent, *though perhaps widely different in their origin.* Of the Leicestershire breed I say nothing in this place, as I may hereafter have occasion to speak of it fully. The Teeswater breed falls within the inten-

tion of the present work. *These sheep have been inhabitants of the banks of the Tees time immemorial.* I remember them twenty years ago, of enormous size, resembling, when their wool was in full growth, the smaller breeds of cattle rather than sheep. Their flesh nevertheless was of an excellent quality; their wool (as long wool) fine, and of an uncommon length, singularly adapted to the worsted manufactory. The present fashionable breed is considerably smaller than the original kind; but they are still much larger, and fuller of bone, than the Leicestershire breed. They are not so compact, nor so neat in their form, as the Leicestershire sheep; nevertheless the excellency of their flesh and fattening quality is not doubted, and their wool still remains of a superior staple."

In these crossings between the Teeswaters and the Dishleys, which Culley pursued; and between the Teeswaters and the old Wiltshires, &c. which the brothers Colling pursued; and an amalgamation, which subsequently took place between the two new sorts, originated the modern Cotswolds, which take name from the Cotswold district, in which they first had extensive introduction on wandering from their northern locality As the Dishley breed had really Lincoln blood in them, it is evident from the language of Marshall, that he considered the Lincolns and the Teeswaters as being unconnected in origin.

The following quotation from Bailey's view of the agriculture of the county of Durham, which is bounded on the south by the river Tees, will bring Australians acquainted with ancient sheep of the *Teeswater breed*; and will bring down the crossing operations of Colling and Culley some years later than they were brought by Marshall:—"Sheep.—Teeswater and Leicestershire.—The lower part of this county was formerly famed for having the largest breed of sheep in the kingdom, many of them being from 50 lbs. to 60 lbs. a quarter; one in particular, a four shear sheep, bred by Thomas Hutchinson, of Sockburn, killed and exhibited at Darlington, the 22nd December, 1777, was 62 lbs a quarter. I saw the carcass of this sheep, and regret very much not having seen him when alive; but I saw one soon after belonging to Mr. Dinsdale, of Newsham, that weighed 54 lbs. a quarter, which was nearly the height of a Shetland pony. A lamb of the Sockburn breed, five months and four days old, bred by Henry Hutchinson, was killed at Stockton races in 1794, which weighed 22 lbs a quarter. Soon after 1777 these great weighted sheep began to lose ground very fast, as the Dishley sheep were then making a rapid progress; Messrs. Culley having been in the habit of letting tups for several years before, by which means most of the principal breeders had gotten crosses with the Dishley sheep, and of course the size and weight of the original stock were much diminished. Some time after this Robert Colling began to visit Leicestershire, and for several years afterwards hired some of their best tups; he also purchased ewes of the most improved breeds, by which he has long been in possession of a very superior sheep stock. Charles Colling, following the footsteps of his brother, pursued the same course and with the same success."

Tuke, in his View of the Agriculture of the North Riding of Yorkshire, published in 1800, states that "a Teeswater wether, rising three years old,

bred by W. Powley, of Thornton, was killed at Leyburn, in January, 1799, the four quarters of which weighed 16 stone 11 lbs.—near 59 lbs. per quarter; tallow, 1 stone $8\frac{1}{2}$ lbs. He cut 6 inches thick of fat on the rib, and $4\frac{3}{4}$ on the rump." Taking age into consideration, this extraordinary wether appears to me to have been equal to the old Lincoln wether, to which I have before alluded.

Culley, who has the reputation of having originated the *modern Cotswold breed*, by the intermixture of the Dishley and the Teeswater blood, thus writes of the Teeswater breed, in his Observations on Live Stock, of which the 4th edition, from which I quote, was published in 1807:—"The Teeswater breed differs from the Lincolnshire, in the wool not being so long or heavy; in standing upon higher, though finer boned legs, yet supporting a thicker, firmer, and heavier carcass, much wider upon their backs and sides; and in affording a fatter and finer grained carcass of mutton, the two year old wethers weighing from 25 lbs. to 35 lbs. per quarter; some particular ones, at four years old, have been fed to 55 lbs. and upwards. Thomas Hutchinson, of Stockton, an eminent breeder and grazier, had a wether sheep, which was killed at Darlington about Christmas, 1779. The four quarters weighed 17 stone 11 lbs., at 14 lbs. to the stone, or 62 lbs. 4 oz. per quarter, with 17 lbs. of tallow (after leaving all they could in the loins); which is the greatest weight, by several pounds per quarter, I ever heard of a sheep weighing. He was of the true old Teeswater breed. There is little doubt but the Teeswater sheep were originally bred from the same stock as the Lincolnshire; but, by attending to size rather than wool, and constantly pursuing that object, they have become a different variety of the same original breed. The ewes of this breed generally bring two lambs each, and sometimes three. There are instances of even four or five, as was the case with Edward Eddison's ewe, which, when two years old, in 1772, brought him four lambs: in 1773, five; in 1774, two; in 1775, five; in 1776, two; and in 1777, two. The first nine lambs were lambed within eleven months. This breed is, at present, rarely to be found pure, except in the possession of some old breeders." I think it possible that both Culley and Bailey refer to the same individual sheep, but that is immaterial; I however call attention to the difference in conclusion between Culley and Marshall, as to the origin of the breed, though Culley's conclusion has not affected my own impression, that the old Lincoln and the Teeswater breeds had not a common origin. The prolific tendency of the Teeswater ewes is an invaluable peculiarity, which is, in my opinion, indicative of a distinct derivation, for the old Lincolns do not possess that tendency.

Henderson, in his recently published Treatise on Live Stock, (after adverting to the Lincolnshire and the Dishley breeds, and treating the Dishley breed as a variety of the Lincoln breed, thus writes:—"The Cotswold, or Teeswater breed, is the only other long wooled one that demands our notice, owing its celebrity to Mr. Culley's exertions in crossing the local animals with the Dishley breed. It is distinguishable from other long wooled breeds by a large tuft of wool covering the forehead, and is the heaviest of the species: likewise more compact, better shaped, and finer in the bone and quality of mutton, than any other equal in weight. These sheep are next in

repute to the Dishleys, and answer well to cross them with, but, like all other animals of a large mould, require good land, well sheltered, and a little nursing in winter, with succulent food. They are very prolific, having mostly two, and sometimes three lambs at once: even instances have occurred of four or five being produced at a birth." I have to remark, that I think Henderson has somewhat overstated the general prolific property of the Cotswolds, and that, as his cited authority is solely that from Culley, as to Eddison's ewe, which, it is to be remembered, was not a Cotswold, but an old Teeswater, I do not think his text, in that respect, sufficiently supported. Couples are, however, common in some flocks of Cotswolds, and I have known instances of three healthy lambs at a birth. I have seen a few fine Cotswolds in Victoria, and I think it likely that when irrigation shall make food plentiful and certain, Cotswolds, being now abundant in England, will be largely imported into Victoria. Pure Teeswaters have been long excessively rare. The last genuine Teeswater sheep seen by me were a remnant flock, located in Leicestershire, which I rode several miles, thirty-three years ago, purposely to see. The ram was aged and equal to an ass in size, and had an amazing fleece. There existed, some years ago, a feeling among sheep breeders of the larger sorts, that, on national grounds, the purest of the remnant flocks of the old Lincoln and the ancient Teeswater breeds ought to be collected together and preserved from admixture with other blood, as breeds worthy of revival, because of their pre-eminence in size, and in length and weight of wool, over every other variety of sheep. I trust that that feeling was acted upon, and that a score of the most symmetrical of the ancient Teeswater ewes, with a couple of rams, accompanied by a like selection of old Lincolns, will find their way into the Park Royal of Melbourne, and be there kept as pure breeds, for the use and benefit of such of the sheep breeders of the colony as may have occasion to revert, in sheep experimenting, to fountain head blood, in cases demanding carcass, size, and extraordinary length in the staple of wool.

To the epicure liking of the citizens of London for early lamb, we are indebted for the preservation of the *fine wooled Dorset breed* in a state of comparative purity ; and if, as is probably the case, the Dorsets represent in ancestry, not only the pink nosed Somersets, the known progenitors of the ancient Cotswolds, which originated the Merino breed, but also the Ryelands, which Bakewell is believed to have used in his cross, the lamb-loving Londoners have in troth, in their palate gratification, conferred a boon on their antipodean brethren by that preservation. Fifty years before the era of Bakewell, Dorset ewes had been found to arrive at early maturity, to possess great fecundity, and to make excellent mothers. This combination of qualities led to Dorset ewes in lamb becoming very marketable animals, and to the extension of the breed in the counties contiguous to London, for early lamb supply. The broad, deep, and cow-like formation in the loin of the Dorset ewe, indicates the faculty of yielding milk in abundance; and Dorset ewes do in fact exceed every other English breed, in the production of milk, which makes them eligible as a cross for the Merinos; the ewes of which on the contrary, yield but little milk and have the repute of being bad mothers. It is said that the fecundity of Dorset ewes, indicates deri-

vation from warm climate flocks, which have the faculty of producing twice a year. Be that as it may, there are certainly English instances on record, of two lambings of the same ewe within the space of a year ; and it is no unusual thing for Dorset ewes to become impregnated whilst they are nursing their young. Upon the whole, this valuable fine wooled breed possesses so many properties desirable in Australian flocks, that I marvel its introduction as a general breed has yet to be made.

Tomkins, the great improver of the Hereford breed of cattle, did much to improve *the Ryeland breed of fine wooled sheep*, located in Herefordshire, but he did not succeed in his endeavors to enlarge it to the paying size, which would have enabled him to compete with the Dishleys and the South Downs. He got symmetry, but not size; and he pleased himself as to wool: but he lived in an age and country in which mutton was at premium and fine wool was at discount. Some flocks of his improved blood lingered long in his locality, and, when I was making my agricultural survey of Herefordshire, I thought of securing a score of ewes and a couple of rams, as an Australian speculation, lest his renovated blood should get altogether lost in an influx of crossings with the Merinos, at the time John Bull (overlooking climate drawback) was, a second time, engaged in his enthusiastic attempt to supersede Spain, in a staple which Providence had reserved for his Australian sons. Both Dorsets and Ryelands are admirable folding sheep, and have been found to cross well with Dishleys and South Downs, and would, I have no doubt, by interbreed, improve, both in wool and mutton, many Austral-Merino flocks. Wool, in Australian breeding, should have at least equal development with mutton, and I look forward to the combination of care, keep, and climate, producing, when directed by intelligence, results in Australian shepherding greatly in advance of present expectation. The best Dorsets, the improved Ryelands, and the giant Lincolns and Teeswaters, might all of them be introduced into Australian husbandry to advantage; and it will be well to ascertain, by continued observation, what ameliorating effect the climate of Australia will have, not only on the long wool of the old Lincolns and Teeswaters, but also on the wool of other varieties of sheep. The *Hampshire Down* and the *Shropshire Down* are new varieties of sheep, which are worthy of Australian notice, as exhibiting good combinations of wool and mutton; the Hampshire Downs are the largest sheep of the short woolled class, and, when pasturage and sheep keep shall, by means of irrigation, become abundant, size in sheep will become a greater object in Australian husbandry than it is at present. The improved South Down flock of Jonas Webb, has justly acquired great repute, and is well worthy of Australian notice, but choice rams are very costly. With regard to Shropshire Downs, which are short wooled and bear some resemblance to South Downs, I was amused at being able, at a Victorian show, to renew acquaintance with a Shropshire Down ram, which had here taken a South Down prize, to which, though he was a fine sheep of his sort, and had to my knowledge taken high English prizes in his proper class, he had no title. The Jonas Webb part of the pedigree, tied round his neck, if not altogether fictitious, was very erroneous; and, though friend Webb might have overlooked his own metamorphose from a Cambridgeshire farmer into a Shropshire squire, he would have

thought, with myself, that the awarding judges had been men of defective vision. There are some *Asiatic breeds of sheep* worthy of being inquired after, and, perhaps, of introduction, to impart special properties to Australian flocks ; especially the purik breed of Thibet, which lamb twice, and admit of being shorn twice in the same year.

I do not contemplate providing domain accommodation for more than its breeding ewes and its fatting sheep, because store and clip sheep may have station care elsewhere, and so yield place and food to dairy cows, which cannot be so well managed as at home: and it will be found that, when sheep runs become of the moderate extent of a quarter of a geodetic square each (*i. e.*, 6,250 acres) many owners of maximum domains will, either in coparceny or in severalty, occupy runs as outlying domain adjuncts; a mode of occupation of much greater advantage, both to individuals and the community, than any system of commonage.

Neat Cattle constitute my second animal class. Much as I am inclined to encourage the growth of oranges in Victoria, I am, nevertheless, of the opinion of an English sailor, alluded to by Sir John Sinclair in his Code of Agriculture, who decided that a Cheshire cheese was a nobler product than a Seville orange. The sailor had been taunted by a Spaniard with a display of oranges, which, the Spaniard said, his country produced *twice a year* ; to which the sailor retorted by holding up a great Cheshire cheese, and exclaiming:—" See what my country produces *twice a day*."

The cow is a remarkably docile animal, and bears confinement so well that I am satisfied *dairying* may be profitably conducted, under soiling management, if the cows are kept in well ventilated sheds by day, and have morning, evening, and night pasturage, whenever the weather is dry and favorable. Though Devonshire men will import Devons, Herefordshire men, Herefords, Lancashire men, Long-horns, and the generality of the colonists the improved short horns; and ought, all of them, to receive colonial contribution towards their cost; my mind has been long made up, that the best breed for Victoria, and probably for the other Australian colonies also, is the improved short horns, *of the milking sort*, with two points out of three to the mind of the dairymaid and one to that of the butcher.

It will be Utopian to expect that cows of a breed predisposed to fatten, will be such milkers as those which have the contrary predisposition. Nature is, however, accommodating; and though she will, properly, refuse to ordain that the fatting propensity shall pass exclusively to the males of a breed, so as to make all the females great milkers, she will not decline to fix a given combination of the two properties, descendible to both sexes, when an Australian Charles Colling shall have produced it.

As the improved *short horned breed of cattle* appears to me predestined to be the dominant breed, not only of Australia, but of the civilized world also, a concise account of its origin, which happened to be in Holderness, where I resided several years in the early part of my professional life, may be acceptable.

Holderness tradition attributes the great milking capacity of Holderness cows to the introduction, some ages back, of Holstein bulls, *viâ* the port of

Hull, which greatly improved Holderness herds, and led to a great demand for Holderness bull calves in other Yorkshire localities. Cleveland was in those days a noted dairy district, and my father, on the authority of his father, who was a Cleveland farmer and breeder of short-horns, told me that Cleveland cows had Dutch Holstein blood in them, which they got with Holderness bulls, purchased for the dairies of Cleveland; and that it was with Cleveland cows, of Holderness and Holstein lineage, that Charles Colling and his brother Robert began, towards the close of the eighteenth century, their amazing development of the short-horned breed.

The Agricultural Report of the County of Durham, to which I have before adverted, discloses, in the following paragraph, what a great result in a particular case followed a lucky incident:—"In the spring of the year, Mr. Basnett, of Darlington, purchased a cow with a bull calf at her heels, and putting her into a good pasture, she got so fat that it induced him to dispose of her to a butcher in the August following, and the calf was sold to a farmer in the neighborhood. At four years old he was purchased by Mr. Robert Colling, who, finding him to have a great propensity to get fat, sold him to his brother Charles, who was then beginning to breed, and was anxious to select those with the best disposition to fatten. For the same reasons, and with the same view, he soon after purchased of Mr. Maynard, of Ayreholm, a cow, and a heifer, her daughter. This bull and cow, selected with so much júdgment, are the original stock from which the celebrated Durham ox, and the justly acknowledged superior breeds in the possession of Charles Colling, Robert Colling, and Mr. Mason, are descended."

My father, who knew both Charles Colling and his brother, and their stock, told me that the cow with a bull calf at her heels was a cottager's cow, which he was allowed to feed in a grassy lane, where she happened to be noticed by Mr. Basnett, and that the calf became the celebrated bull, "Hubback," the common ancestor, not only of "Comet," the first bull which sold for a thousand guineas, but also of all the Colling herd, which figure so prominently in the short-horned herd books. "He was but little for a Teeswater bull," said my father, "but he handled well, and was good in all his points. His want of size was set down to his bad keep as a calf, for the cottager's wife took care that her children shared better than the calf in its mother's milk."

The origin of the modern improvement in the *breed of Herefords* was almost as incidental as was that of the improved short-horns. It was thus. About 1769, Benjamin Tomkins, of Kings-pyon, in Herefordshire, began breeding from two cows, called by him "Pigeon" and "Mottle," bought at Kington fair for a dairy farm, of which Tomkins was the cowman. He had noticed the propensity of both cows to fatten, and on marrying his master's daughter, asked for, and had the two cows in dowry with his wife; and a famous dowry it proved to be to him.

The Herefords are not, however, adapted for dairying, which is the crowning purpose of the bovine race; and they must, therefore, together with the Devons, yield place in Australian husbandry to the milking variety of improved short-horns, which is likely to become the universal breed of the civilized world. When I made my agricultural survey of Cheshire and the

other dairy districts of England, I found the long-horns, which had long held dairying supremacy, gradually becoming of the short-horned type, by the introduction of short-horned bulls, and by the facile manner in which that type was stamped on the progeny in the very first cross; and when I afterwards made my agricultural tours through Scotland, Ireland, and France, I was surprised at the number of short-horned cows which met my eye in every direction. I was much gratified, also, at finding, both in South Australia and Victoria, more useful cows of my favorite breed than I expected to find.

As an ounce of forethought, in the ordinary affairs of life, is worth more than a pound of after-wit, because it may supersede, by anticipation, the routine of costly experiment; and as I see an error into which Australians are falling in awarding prizes to fat bulls and cows at cattle shows, and in purchasing at extravagant prices English prize bulls and cows of Smithfield fame, which every man of experience knows are generally the fattest of the fat, instead of those which have taken dairying prizes; and as fatness is inimical to fecundity in the female, and to labor in the male, and, moreover, counteracts nature in her efforts to supply milk; and as we shall be long without a beef-eating population in Australia, I do protest against paying extravagantly high for that which is not only not yet wanted, but which may for many years to come be positively injurious. Moreover, beef will never be of the consideration in Australia at which it has arrived in England, inasmuch as it will have to encounter far greater rivalry with mutton than English beef ever had. The immense flocks of sheep which will be kept for what is now justly regarded as the great staple of Australia, will soon, in mere annual cullings, yield ample animal food for a much greater population than Australia is likely, for many years to come, to have to eat it. In addition to that, it is to be borne in mind, that decomposition is so rapid in Australia, that however desirous a country butcher might be, to treat his customers with prime Christmas beef, he would scarcely venture upon killing an ox until he saw his way to the disposal of the whole of it in as many hours as an English butcher can allow days. The greater portability, therefore, of sheep is of such moment in the rivalry between beef and mutton, as almost of itself to settle the question between them; but, when it is remembered that alpacas, llamas, yaks, goats, kangaroos, and hosts of fur-clad and other animals, together with vast supplies of poultry, swine, calves, and fish, will shortly compete with both beef and mutton, it will be obvious that, in a country which for ages to come will be without its Londons, Manchesters, and Birminghams, &c., the breeding of cattle for the mere production of beef cannot pay, and ought not, therefore, to be persisted in, beyond making the best of aged cows and of the oxen in surplusage of the demand for labor, and that henceforth the prize bulls and cows to be imported, and the awarding of colonial prize encouragement in the breeding of neat cattle, ought to be limited to those which have the milk-producing faculty in fullest development, combined with symmetry and constitutional proneness to keep in that store condition in which good keep will induce a moderate degree of fatness when the ox is to rest from his labor, and the cow is to retire from dairy duty.

There are in England several invaluable herds of improved short-horns, in which the fatting propensity was never allowed to proceed to the extent now necessary to ensure first class Smithfield prizes. Bailey, the judicious author of the Durham Report, from which I have twice before quoted, writes thus :—"It has been already stated. that the short-horned cattle were great milkers. This cannot be said of the variety which has such an aptitude to fatten, for though they give a great quantity for some time after calving, they decline considerably afterwards; but the variety of great milkers is yet to be found wherever the dairy is the chief object, and this variety is as carefully preserved and pursued as the graziers do that of the fatting tribe. It is very common for cows of this breed in the beginning of summer to give thirty quarts a day, and there are particular instances of more. Where the object is simply milk, they are probably superior to any breed in the kingdom; but in respect to butter and cheese there are some doubts as to whether they are entitled to claim a superiority or not, as the quantity of those articles does not depend entirely on the quantity of milk."

The yak of Thibet is an animal of the bovine race which appears to me to be worthy of Victorian introduction. In addition to the three-fold yield of milk, beef, and extraordinary hair, it yields also horns of superior length and make, and has a tail which is used in India as an appendage of State parade, and is therefore of commercial value. The yak is, moreover, used as a beast of burden in Thibet, and having the repute of being strong and sure-footed, I see no reason why it should not in Australian husbandry supply the place of the ass. The hair of its hump is in reality a kind of fur. The Tartars have large herds of them, which are to them valuable, for they live almost entirely on their milk. The male is five feet high, and has much the form of an English bull, but its chief dissimilarity, with other animals of its genus, consists in its sides being covered with long glossy hair, which extends over the whole body except the head and legs, and hangs from the flanks quite down to the hocks. The hair is in great request, and is sold at a high price. The dhe, or cow, yields a large quantity of milk, which is rich, and produces better butter than that of any other of the bovine races of Asia. If, therefore, travellers have not over-stated the qualifications of this animal, they are, in combination, so manifold as to call for especial and early attention.

Before I pass on from the bovine race I must reiterate, that its paramount mission and crowning purpose in animal economy is dairy produce in the cow, and labor in the ox, and that the great development and prominence of its beef-yielding property, which Charles Colling and Benjamin Tomkins, and their skilful compeers, induced in their varieties of the race, would have been of little consequence elsewhere than in England, where an increasing beef-eating population demanded additional supply ; and where the climate permitted that supply to be stored several days, and in cool weather a week, without spoiling, whereby a village butcher could risk the killing of his weekly ox. I have also to observe, that excessive fatness is disease, and that breeders have made that disease constitutional, by perpetuating predisposition to it. It was noticed (said my father) that though the mother of Hubback (the originator of the Colling herd) was a young

cow, she never bred after she got promotion out of the lane into good pasturage, notwithstanding the great anxiety there was after she became noticed for further calves. Sterility, the baneful adjunct of high breeding, is of dangerous tendency in a dairying herd, and ought to be counteracted by vigilant care.

It is, therefore, prize bulls and cows from herds of short-horns which have the milking faculty preponderant, and especially from the herds of Holderness, which yet supply the vast city dairies of London and Manchester, &c., &c., with their best milking cows, which I am anxious to see imported into Victoria, accompanied by English dairymaids of the cheese-making districts. I have during a long professional connection with Cheshire and the cheese-making parts of Shropshire and Staffordshire noticed, on coming in contact with factors, in their periodical cheese-purchasing visits, that they were much more influenced in their buyings by the reputation of the dairymaid, than by either the soil or the herbage of the farm; and, though I have observed that some pasturage and soils are better adapted for cheese-making than others, the result of my experience is, that more depends upon the care and management of the dairymaid in the production both of butter and cheese, than upon either the soil or the herbage of the land. It will be absolutely necessary in Australian dairying to have buildings with regulated artificial temperatures, adapted to the known requirements of certain operations connected with the making and keeping of cheese and butter; and I have, in conclusion, to urge the introduction of the cleanly system of the Flemings and the Dutch in their management of cows into Australian dairying.

Horses stand third in my animal classification. The vicinage of Victoria to the fountain head of Arab blood, and the regular communication between the colony and England, by which the best breeds of the mother country can be easily imported, are much in favor of the colonists. The horses of Victoria, in some points, surpass the generality of the farm-bred horses of England, which I have heard attributed to the introduction of Arab blood, *via* India, in the early days of Australian settlement. The diminutive horse of Timor is one of the best of his sort. It is not perhaps generally known, that the powerful dray horses of London are thrown up to their great size by the intermixture of pony blood from the male side. It is my opinion that brood mares of the medium sorts as to size and strength would during the greater part of the year draw speedily and well trains of carriages to and fro along the tramways of the domain with manure out, and with soiling food and other produce in, and do much other light husbandry work, without injury either to themselves or to their progeny; and I would suggest, that as all the brood mares need not foal at the same time, it might be well so to regulate the horse-labor of the domain, as that the bulk of it might be done by brood mares, especially when steam-ploughing becomes general. Horses will not, however, in Australian husbandry ever arrive at the degree of importance assumed by their brethren in English husbandry, inasmuch as in addition to oxen, with which alone English horses have hitherto had rivalry in labor, they will in Australia have to

compete with camels, dromedaries, yaks, alpacas, and llamas; and last, not least, with the steam-plough, and various other applications of steam power, the era for which is in the dawn. The Indian market for cavalry horses will always, however, be an important one to Australia, and will induce the impetus to horse-breeding, which is necessary to keep stud arrangements up to any thing like English notions of due importance. If it was not for that circumstance, I should have placed camels before horses in classing the zoologicals of a Victorian domain, it being my opinion, that a few years hence there will be only limited call (save for Asiatic war service) in any of the Australian colonies for horses at prices which will remunerate the breeder.

The Camel family, in which I include as well the camel and the dromedary, as the alpaca and the llama, shall have my fourth place. "The ships of the desert" appear to me to be expressly adapted for Australian husbandry, and it is well that they are comeatable on comparatively easy terms as to purchase, for, judging by the cost of the Victorian railway experiment now in trial, ages must elapse before railway transit can be extensively anticipated, however great may be the yield of nuggets. The formation also of great lengths of ordinary road way is tedious, and if pressed hastily on becomes much more costly than might be the case under leisurely arrangement. It ought to be, therefore, matter of thankfulness, that when under the necessity of adopting the antiquated mode of pack transit, we have the camel tribe at command. In Victoria, which will for ages to come be a country of "rush" and migration, the substitution of camel transit for the slow, cumbrous, and costly bullock-dray system hitherto in use, will be a colonial blessing; and one of its effects will be, to relieve distant interior road boards from much premature expenditure, because laden camels and dromedaries can trot up and down uneven land, and over marshes where it would be impossible to urge onwards a loaded dray. The alpaca and the llama are used as beasts of burden in their native countries, and may be here made to discharge the duties assigned by British husbandry to asses and to ponies, and as they both of them yield food as well as wool, and that too more than sufficient to pay for their care and keep, they are on that account to be preferred to either ponies or asses, which yield labor only. In conveying dairy produce, poultry and game, fruit and vegetables, and other produce, to distant gold-field markets, alpacas and llamas, together with young camels and dromedaries, will be found very serviceable, the alpaca and the llama being reported to be both sure footed and docile. There can be no question as to the eligibility of investment in camel tribe breeding, and the sooner it is set about as a regular branch of Australian husbandry the better.

The Kangaroo family shall have, as of right, my fifth place, and I marvel that the domestication, propagation, and improvement of this interesting family has not already become a department of Australian husbandry. The large kangaroo is a noble animal, and is of more than ordinary value, both as to flesh, fur, and hide, and as it will soon come into payable demand

for British and European parks, and for zoological and other gardens, it is time that this decided staple of Australian produce became duly appreciated as such, and its domestication and propagation were set about systematically. Sound principles of breeding and judicious crossing among existing varieties will probably result in the formation of new varieties, and in the better development of the family. The marsupiates constitute a very interesting group of the animal kingdom, and some of those of America will be found deserving of the thought of the Australian breeder in his persistent development of the whole group, and looking at the easy terms on which Australia transferred his vast dominion to Great Britain, I shall propound on behalf of Europe, that a trust to accomplish that development of this, the first in import, of nature's animal gifts to Australia, passed by implication with the transfer; and that that trust attaches on every delegation of self government by the British crown to its Australian colonies. I trust, therefore, that in the zoological establishment intended to be located in the Royal Park of Melbourne, kangaroo domestication and breeding will be paramount objects of early care. I saw at the great English Industrial Exhibition of 1851 a large pig, which had been cured and made into good bacon, without dismemberment, save embowelling; and though a pig is, perhaps, the awkwardest of all animals for such an experiment, the curative artist had overcome his difficulties so well, that I am impressed with the belief, that most of the edible animals of Australia could be so cured. Ingenuity could scarcely devise either an animal or a posture better adapted for preservation entire, as a festival dainty, than a non dismembered kangaroo in a state of rest on his haunches. With the small varieties there would be but little difficulty, and there can be none whatever in curing the haunches and other prime parts in separate joints, and in making preparations of the tail for soup. If therefore John Bull shall really, as Mr. Michie's friend recently suggested, take a liking for kangaroo sausages, (and Melbourne is really predestined to vie with old Bologna in the sausage trade, as Mr. Michie predicts,) there will be, in troth, a new Australian staple in the kangaroo family, both alive and dead. The curative chemistry of the colony at all events ought to be encouraged, and it may be well to import with Aberdeen pickled and preserved fish and flesh, half a dozen professors of the curative art.

The Goat family, and especially the fine haired varieties of Cashmere, Angora, Thibet, and California, appear to me to have claim to my sixth place. I have, however, to testify that the goat of Britain is a mischievous animal in plantations, and among young quickset fences, and that he is under ban in his last strong hold—the mountains, by prohibitory clauses in Welsh leases, wherever improvement and English culture are to be introduced. Perhaps inefficient domestication was to blame for some of this as much as the goat. It may much expedite the introduction of the fine haired varieties, and lead to the general improvement of the goat family, if instead of commerce with ordinary males, the females of the races already in the colony are introduced to males of the more valuable breeds, when those breeds shall have been imported. The milking faculty of the

goat (which may be called a miner's and the poor man's cow) is worthy of thought in its development, and the size of the goat may probably be increased to advantage. I observed when I visited English Brighton many goats employed in drawing the light carriages of invalids and children along the sea beach, a service which they performed with great alacrity and in an admirable manner. I mention the circumstance as a hint in case Victorians, should have occasion to exact similar duty, and especially in case the animal shall by crossing increase in size and strength. My note book records that naturalists have held that goats and sheep will interbreed, and that the progeny will be fruitful, but I do not vouch that fact, and I mention the matter merely as one worthy of inquiry. A combination of hair and wool may be better for some purposes than either material alone; and I am sure that a fat mutton admixture would have improved all the goat's flesh which it has been my lot to taste. The ancient Teeswaters, the Dorsets, or the old Lincoln sheep are what I should first experiment with, if I was induced to make the attempt.

Swine, which transmute refuse of every kind into valuable pork and bacon, are entitled to my seventh place. I like the pigs, both of Victoria and South Australia, but I trust that the fat mania will not be permitted to spoil Victorian pork and bacon for sea use, which ought to be a leading object in the husbandry of a maritime colony. Probably an artificial moderation of temperature will be necessary in hot weather during the curation process, to ensure a first-class article; and if so, that temperature ought to be provided.

The lesser fur-clad, and edible, and useful animals constitute my eighth class, among which those which are indigenous to Australia shall, as of right, have first place. Opossums, wombats, porcupine ant-eaters, and the ornithorhynchus paradoxus, which will all pay for domestication and care, will serve to indicate this class so far as Australians are concerned; and hares, rabbits, and beavers, together with ferrets, genets, and other vermin destroyers, will suffice to indicate the kind of alien immigrants which shall have naturalization in the class; which, when formed and placed under the care of the male juveniles of the domain, will afford them fine scope for their first essays in thought and labor. The English variety of rabbit called the silver grey is to be preferred, because of the greater value of the skin in Chinese estimation; and I may remark, that rabbit warrens will probably profitably pioneer the appropriation of loose sandy districts, by bringing them under ownership, and enriching them with rabbit dung, which is of considerable value as a manure.

The poultry yard of a Victorian domain will be such an important concern, and such an admirable field for feminine care, that I shall constitute it my ninth class, giving, as of right, precedency in place to the emu, the menura-superba, and native turkies, swans, geese, ducks, pheasants, and such other feathered Australians as will submit to the degree of domestication required to pass them within the pale of the vast feathered com-

munities which Victorian poultry yards are predestined to become, when the east and the west, the north and the south shall have sent their delegates to mingle in the monster gabbles of Victorian domains. I was interested, on a visit to English Warwick, with some ducks unusually long in the leg, which attracted my notice, and seemed to be quite at home with other ducks in the mill pond under Warwick Castle. I was told by the miller, that a gentleman curious in such matters had procured the eggs from some place beyond the Cape, and had hatched them under English ducks. Every egg had produced its duck, and those in the mill pond had been sent as a present to Lord Warwick. With China and India so near, and with such facilities as the overland route gives for bringing out the eggs of game and of other birds from England to be hatched here, who will venture to limit the feathered subjects of a thrifty Victorian dame, at the head of a first-class domain poultry yard! The Warwick miller could not tell me whether the duck eggs had been subjected to any process to preserve vitality, and I regret that I was unable to linger so as to pursue inquiry. The case, however, evidences that some feathered introductions may at all events be made in the egg state.

The silk worm, the cochinella, and the bee, as the nucleus of a municipality of lilliputian industrials, shall form my tenth class, with power to receive such other tiny brotherhoods into membership as may be able to yield commensurate return in the way of product, for their food, care, and cost.

As every grantee of a maximum domain will, as soon as practicable provide capacious ponds and reservoirs for the purposes of water storage and irrigation, the economy of stocking those ponds and reservoirs with such *fish* as can be brought into a state of semi-domesticity presents itself to notice. Fish ponds have long been in Europe a branch of rural economy, and several treatises have been written on their management. Change in diet is at times salutary, and as a store of living fish becomes of consequence and value in places remote from the sea coast, and distant from a river, I shall introduce fish as my eleventh class, and instance eels, pike, perch, dace, carp, and tench, the guramier, tortoise, and crayfish, together with such of the fresh water fishes of Australia, and Australasian rivers and lakes, as can be brought to acquiesce in the monotony of pond life, as a fair stock of freshwaters to begin with. If it is true that the flounder and the mullet have acceded to naturalization in fresh water, they may be added. In localities connected with estuaries or with the sea coast, and peradventure also in artificially made saline water ponds, the water collected for grass land irrigation may be made to supplement the fresh water yield by contributions of salt water varieties.

My twelfth will be a miscellaneous class, to consist of antelopes, gazelles, English harts, and other kinds of deer, and of such other domesticated animals as shall be deemed worthy of introduction into Australian husbandry, but which happen to be ineligible for admission into any of the foregoing classes, formed, as is evident, with a view only to profit. The

shepherd's dog, together with hounds and some other dogs, and also the ass, will fall properly into this class, though I do not see opening in Australian husbandry for the services of the ass, because it happens to have nothing but labor to offer, whereas its laboring competitors, the yak, and the llama, &c., offer also food, &c., &c, in addition to labor, and will of course have preference. I may remark, in conclusion, that though I have confined my attention exclusively to such zoologicals as will pay for breeding and feeding, I am, nevertheless, inclined to countenance a given degree of encouragement to the keeping of animals for the objects of science, sport, or curiosity. The English hart is so greatly superior, as an animal of chase, to that cunning poultry thief the fox, that I trust Mister Reynard will never be allowed to become an Australian immigrant, and that, when the last of the dingoes shall have shared the fate of the last English wolf, Australian Nimrods will resuscitate, at the antipodes of England, the sterling old national sport of hart hunting, conjointly with that of African boks, gazelles, and antelopes, and leave the fox to their English cousins, who cannot have Australian choice.

I come now to the supply of food for the many zoological subjects which I am appending to a domain, and to a consideration of my ways and means for their sustenance. Some permanent pasturage and meadowing is essential where much stock is kept, and I think some modern notions on the all-sufficiency of what is called the alternate grass and tillage system, for stock supply, fraught with mischief. In prescribing the seeds to be sown in the fields which I have set apart for permanent grass and herbage, I was determined in the preference which I have given to English varieties, solely because their alimentary properties have been well ascertained ; and in my selection of sorts I was guided by the result of my own experience, which has, in that respect, been much more than usually extensive. I am, however, persuaded that in the course of years botanical science will reveal to the Australian husbandman many indigenous grasses and herbage plants worthy of culture and improvement by hybridization, &c.; for I entertain too exalted an opinion of the wisdom and benignity of Providence and of Nature, to suppose that such a vast region as Australia has not plants especially adapted to the peculiarities of its climate ; but, until it shall have been ascertained what those plants are, and what effect they will have on animals of European origin, we must be content to walk in the safe path of experience, and avoid labyrinths, unless and until they may be entered without endangering the healthy existence of our flocks and herds.

For the hospital crofts, which I have provided for diseased and weakly animals, producing-females, lambing ewes, rearing calves, and ready turn out on occasional purpose, &c., &c., &c., and in which I would erect a cote, where it would do not only for both crofts, but also for the adjoining field, which, by reason of its position, I have called cote paddock. I would, in imitation of medical practice, tempt appetite by the introduction of a few herbaceous dainties beyond what I conceive to be necessary in other cases : the following is the admixture of seeds which I would suggest :—One-eighth white clover (*trifolium repens*), another eighth cow clover (*trifolium pratense*

perenne, medium variety,) and alsyke (*trifolium hybridum*), combined in equal proportions ; another eighth hop trefoil (*trifolium procumbens*), yellow trefoil (*trifolium minus*), lotus major (great birds-foot trefoil), lotus corniculatus, medicago lupulina, creeping vetch (*vicia sepium*), wild thyme, trifolium incarnatum, and any other clovers than those specified, in colonial use, mixed in equal proportions ; and another eighth lucern, saintfoin, burnet, yarrow, parsley, and plantain, in equal proportions, making the pasturage half herbaceous ; another eighth the perennial variety of rye grass called Stickney's (after an Holdenness agriculturist who began its cultivation), which is of surpassing merit, and had the commendation of Sinclair, the coadjutor of Sir Humphrey Davy, in the "*Hortus Gramineus Woburnensis ;*" another eighth kangaroo grass and the best of the indigenous grasses and herbaceous plants of Australia, because it will be in these crofts that young Australian animals will have their domestication and pasturage ; and the remaining two-eighths the twelve English grasses called *anthoxanthum odoratum*, *dactylis glomeratâ*, *phleum pratensis*, *alopecurus pratensis*, *cynosurus cristatus*, *avena pratensis*, the three *festucas—ovina*, *pratensis*, and *duriuscula*, and the three *poas—pratensis*, *trivialis*, and *nemoralis*, combined in equal proportions, making the pasturage half gramineous. I am aware that some of the herbaceous plants named are not perennials, but, as these crofts will be always eaten bare, and be thereby kept from seeding, the biennials and triennials will thereby acquire a considerable degree of longevity, so that when, in the course of nature they do disappear, the white clover and other creepers, together with the grasses of tillering habit of growth which happen to adjoin them, will soon usurp possession of the relinquished ground, and keep up the pasturage. The non perennials are, however, introduced too sparingly to be detrimental to the formation of an early and a well stored pasturage.

For the cow pastures I would suggest two-eighths cow clover, one-eighth alsyke, and one-eighth white clover, lucern, saintfoin, burnet, yarrow, and plantain, combined in equal proportions, making them also half herbaceous ; another eighth Stickney's rye grass, a sixteenth *dactylis glomeratâ*, another sixteenth *alopecurus pratensis*, *phleum pratensis*, *festuca pratensis*, and *poa pratensis*, in equal proportions, and the remaining two-eighths the seven other English grasses prescribed for the hospital crofts. The creeping propensity of white clover will lead to its extension wherever there may be failures, and that circumstance will account for the preponderance which I have given to alsyke and cow clover. Moreover, hungry cows require a better bite than white clover affords.

For the sheep pastures I would suggest three-sixteenths white clover, one-eighth alsyke, a sixteenth cow clover, and an eighth lucern, saintfoin, burnet, yarrow, plantain, medicago lupulina, and hop, and yellow trefoils, in equal proportions, and making them also half herbaceous ; another eighth Stickney's rye grass, and the remaining three-eighths the twelve other English grasses prescribed for the hospital crofts, in equal proportions.

For the general pastures (*i.e.* home paddock and cote paddock,) I would suggest one eighth white clover, one-eighth cow clover, one-eighth alsyke, and one-eighth lucern, sainfoin, burnet, yarrow, plantain, medicago lupu-

lina, and hop and yellow trefoils, in equal proportions, making them also half herbaceous ; one-eighth Stickney's rye grass, another eighth kangaroo grass and the best of the indigenous grasses and herbaceous plants of Australia, and the remaining two-eighths the twelve other English grasses prescribed for the hospital crofts, in equal proportions.

For the clover paddock, I would suggest two-eighths cow clover, two-eighths white clover, two-eighths alsyke, and two-eighths hop trefoil, yellow trefoil, lotus major, lotus corniculatus, creeping vetch, medicago lupulina, lucern, sainfoin, burnet, yarrow, plantain, Stickney's rye grass, and dactylis glomerata, mixed in equal proportions :—an admixture of other plants with the clover making the pasturage more palatable, and, perhaps, adding to its nutritive and salutary properties also.

For the lucern paddock, I would suggest six-eighths lucern, one-eighth cow clover, white clover and alsyke mixed in equal proportions ; and the remaining eighth,—hop trefoil, yellow trefoil, lotus major, lotus corniculatus, creeping vetch, medicago lupulina, saintfoin, burnet, yarrow, plaintain, Stickney's rye grass, and dactylis glomerata, mixed in equal proportions.

In regard to the meadow, as there are over a hundred British and European and other perennial grasses and herbaceous plants, worthy of introduction into Australian husbandry, and, as I am persuaded, as I before observed, that many indigenous grasses and herbaceous plants will, in course of years, be found worthy of culture ; I would suggest the carrying of the floating gutters of the meadow, across it from east to west, at equal distances, and so as to divide it, in the first instance, into twenty-six plots of an acre each, which might, by three floating trenches cut at equal distances from north to south, be subdivided, so as to form 104 equal sized plots, by which arrangement that number of distinct varieties might be separately cultivated without confusion, if that number was thought desirable ; and every plot might be seeded too, should there be a demand for seed. Why should Victoria have to send to England or to Scotland for its grasses and herbaceous seeds, save on the first supply and for new varieties, or on change of seed.

The meadow would of course, be formed in the lowest corner of the domain, as the common receptacle of the surplus water from every other part, and the division arrangement, which I have suggested, would test by contrast the comparative value of each plot, all being under similar culture, and would decide also which would pay best for water, if it happened to be scarce. In fixing my proportions of the various plants intended to constitute my pasturage, I have taken the number of seeds, and not either their weight or measure as my criterion, because some seeds are very much more bulky than others, and some again are much heavier than others ; so that neither weight nor measure alone secures satisfactory adjustment. Some years ago when the price of grain was very low in England, and cattle and sheep were paying better than arable culture, I was intrusted with the conversion of extensive tracts of arable land into permanent meadowing and pasturage. The extent of the operation called for great care, and I placed myself in correspondence with Mr. Sinclair, (the coadjutor of Sir Humphrey Davy in their celebrated Bedford experiments, and in the production of the Hortus

Gramineus Woburnensis), and also with Mr. Stickney, an old Holderness friend (who had written on the subject in the communications to the English Board of Agriculture, and had introduced the perennial variety of rye-grass which bears his name into general husbandry), on several matters of detail, one of which resulted in my adoption of a mode of seed distribution grounded chiefly on weight, but applied also to measure, where I thought that necessary. I caused the seeds of carefully weighed packages of an eighth of an ounce each, of every kind which I was about to sow, to be counted, after which the process of multiplication gave me the number of seeds in a pound, and by keeping a record of every counting I had no difficulty in prescribing either by weight or by measure the seeds for every individual field in any pre-arranged proportions. I found it necessary to sow heavy seeds and light seeds by themselves, which I did by sending a row of sowers one after another with mixed seeds of equal weight, to ensure better distribution, but I made one harrowing cover them all. The operation was very nice, and I therefore awaited the opportunity of a calm moist evening, and used only a light whitethorn bush harrow, followed by a roller ; and as grass seeds are hardy, and I invariably adopted autumnal sowing, they soon germinated, and I experienced no difficulty in the humid climate of England, in getting in a few months fair pasturage. I never sanctioned sowing grass seeds for permanent meadows or pastures, along with a grain crop ; and I have a record in my note-book, that in the course of years I paid over a thousand pounds for grass and herbage seeds so sown, which indicates that my operations were greatly in advance of mere experiment. I was in the main successful, and though I had reason in some of my first sowings to be dissatisfied with the vitality of some of my costliest seed, I got over that difficulty afterwards by a testing germinating process before sowing ; and by holding my seedsmen responsible under their guarantees. It is to be borne in mind that the more deeply-rooting a plant is, in its habit of growth, the greater will be its value in Australian husbandry; and that as Nature, when left to herself, invariably provides an admixture of sorts, to keep up a successional supply in her pastures, for the varying seasons of the year, it will, in the formation of artificial pasturage, be wise to profit by the wisdom of such a considerate provision. More moisture, however, than the climate of Australia yields is essential to good meadowing and pasturage; and unless and until irrigation becomes part and parcel of regular Australian husbandry I cannot venture to predict that aught like the evergreen pasturage of old England will greet the eyes of Australian husbandmen, or gratify the palates of their sheep and cows.

I regard the system of giving succulent herbage to cows and sheep, &c., under cover, to which the term *soiling* has become attached, as a great result in modern husbandry, and as being peculiarly adapted for Australian climates, where night pasturage may be indulged in throughout great part of the year. The feeding of cows with regularity at stated periods, under cover, and in a regulated temperature in well ventilated sheds, and the exercise of driving them to their pasture in an evening after milking, and bringing them home to milk in early morn, cannot be otherwise than beneficial to their

health and a great improvement on the fly-tormenting practice of day pasturage; and it is a great argument in favor of the soiling system, that it is applicable, not only to cows, but also to sheep, horses, camels, and goats. Its economy in food, and the greatness of the additional manure supply, to which its adoption will lead, are both of them important objects ; and it is to that additional supply that I look for the share of the homestead manure which will be called for by the special culture department, which it is obvious will yield little manure of its own. Having in an earlier part of this essay, adverted summarily to the cropping of the Victorian course, I shall in this place content myself with the statement, that all the cereals in a green state, the clover and vetch families, all the gramineous and herbaceous plants, and particularly lucern, sainfoin, burnet, plantain, parsley and yarrow, the tops as well as the roots of potatoes, turnips, beets, chicory, carrots, and parsnips; cabbages, lettuces, celery, rape, and other brassicas; gourds, water-melons, marrows, and pumpkins; pulse and lentil crops (as well green as dried), and maize, millet, buck-wheat, hemp-seed, sorghum, and gramme, &c. (in both states), and also rape seed, cotton seed, and linseed made into cake, and preparations from other oil and fruit refuse, may all be made to supplement that course in soiling supply. The great care of the cultivator will be, so to time the succession of his supplies as to avoid superabundance one month and scarcity another. Of course the due storing of roots and of dried fodder will be a paramount object of care.

Sir John Sinclair, who was attached to the soiling system, stated that one acre of cut clover was equal to two pastured, even of the same crop in the same field ; and he instanced a case in which thirty-three cattle were soiled from the 20th of May to the 1st October, on 17½ acres ; when it would have taken 50 acres to have pastured them in the field ; from which he inferred the saving of land to be, in that case, 32½ acres, being in the approximate ratio of two to one.

Curwen, the English agriculturist, who was the first to practise the soiling system on an extensive scale, published an account of his proceedings, and succeeded in his object of keeping working horses and milking cows, in great measure, on steamed potatoes, supplemented by turnips, rape, cabbages, kohl-rabi, and carrots ; in some cases, also, steamed. It was the then enormously high price of hay which led him to the system.

The Rev. W. L. Rham, in his Dictionary of the Farm, states that a cow or an ox requires three acres of English grass land for pasturage and hay, for its keep the year round ; but that, by raising clover, lucern, sainfoin, tares, and other green crops, three cows could be fed with the produce of one acre, especially if a portion was in turnips or other succulent roots.

The Americans, long ago, adopted soiling in dairy management, using green maize, buck-wheat, oats, and rye ; and they also applied the system to sheep. Quincy, one of their senators, who practised soiling on a large scale, enumerates six advantages as resulting from it, viz., the superior condition of the cows, sheep, and cattle, under that management ; greater production in milk, improvement in the quantity as well as quality of manure, saving in land, saving in fencing, and saving in food. An experiment is recorded in the American farmer which showed that 17 acres

of land, under the soiling system, had supported as much stock as had previously required 50 acres, which is singularly corroborative of the statement of Sir John Sinclair; for I have ground for believing that the two statements are grounded on separate premises.

Soiling appears to have found its way into English husbandry from the Flemings, who are now fully developing it in connection with their clever liquid manure arrangements. Though it obtained footing in Hertfordshire and Kent, two centuries ago, it is only of late years that it took permanent position in British husbandry, and became an adjunct of stall feeding, which, however, it now leads. It is rapidly gaining ground also on the Continent of Europe, because it is considered peculiarly adapted for warm climates; and if in the climate of England (as I have seen stated), lucern has risen to the flowering process three or four times in the year, a variety of sainfoin, called the double bearing, has flowered, and even ripened its seed twice in the year, common red clover has, as a rule, flowered twice, and occasionally, even thrice in the year; Italian rye-grass has well ripened two crops of seed in the year, and, when abundantly manured, done even more than that, may we not fairly reckon upon an abundance of food and a great development of the soiling system in the genial climate of Australia Felix, when it shall have the impulsive co-operation of a well organized system of irrigation.

The third, or Victorian special culture branch of Australian husbandry, admits of as much system and regularity in its management as the other two. It is of ample magnitude, and will give an Austral-Oriental import to the whole.

Humboldt has remarked that climate heat is not so dependent on latitude as has been thought, and it is evident to an observant mind that local influences and aspect, as well as latitude, are to be considered in the endeavour to acclimatize new vegetable productions. The isothermal, or line of equal heat which would pass through Australia about latitude 35°, would cross America about 30°, and Europe about 45°. The climate of Australia is therefore better adapted for tropical products in a given latitude than is that of America; and I apprehend that, if acclimating is conducted with care, and comparatively hardy varieties are selected, many tropical products may be reconciled to a North Victorian habitat.

The Colony of Victoria being situate between the parallels of 34° and 40° will, doubtless, produce in perfection most of the staple products of France, Italy, Spain, Greece, and South Europe; of the medium climates of Asia, and especially those of the favoured countries of Persia, Northern India, and China; of

the best regions of America, and especially those of Virginia, Carolina, Georgia, Florida, California, Brazil, and Chili; and also many of the special products of Northern and Southern Africa, and especially of that mother country of culture,—Egypt. It is obvious, therefore, that Australian husbandry will anon embrace the culture of the choicest products of the earth. The banana is reported to have ripened at Adelaide, and I myself, when at Adelaide in 1859, visited the orangery (of several acres) of His Honor Mr. Justice Gwynne, in which trees laden with fruit looked full as hardy and thriving as apple trees in an English orchard. I had thought it advisable, before coming out, to visit the vineyards of France, but I saw none there which surpassed those of South Australia. The Indian shrub Nopal *(cactus opuntia)*. which supplies food for the cochineal insect, and the white mulberry, which is the best food for the silkworm, will both of them admit of easy culture in Victoria, so that the production of cochineal and silk will, ere long, be among the objects of Victorian special culture.

The proportionate quantity of Agraria Domain assigned to special culture is 159 acres, being five allotments of 26 acres each, in addition to the homestead and the private road. I thought it desirable to keep the land of each of the three departments from interference with the others; and the following enumeration and classification of the objects intended to fruit the special culture branch will show its scope and its importance as providing abundance of light and healthy out-door employment for the female labor of the domain, and for children, when strong enough, to assist in gathering fruits and produce, and the drying of tea, and making preserves, &c., &c., &c. The numbers on the plan which have reference to this department are 1, 4, 10, 12, 13, 22, and 25.

I assign the special culture allotment numbered 12 to the vineyard, intending that raisin and table grapes and the currant vines of Zante, as well as wine grapes, shall be objects of vineyard culture. The progress in Australian husbandry of this department has been astonishingly rapid; a vineyard of 26 acres is of itself a little heritage, and, if well managed, will be found to be a source of great profit. The fact that the colony has charge of its own

distillery laws and export duties is very encouraging to intending emigrants. The vine is so easily propagated, and comes so soon into profit, and is moreover so comparatively light in its labour demand, that it is in my opinion exactly the thing for the man of slender capital.

I assign the allotment numbered 13 to the orchard and the orangery, intending that English and French apples and pears, for the manufacture of cider and perry; and the production of apples, pears, plums, peaches, apricots, nectarines, cherries, quinces, almonds, figs, loquats, filbert and Spanish nuts, and black mulberries, which are all legitimate objects of a Victorian orchard, shall, together with oranges, citrons, and lemons, and all other fruits adapted to the climate of Victoria and admitting of orchard culture, yield produce in the shape of jams, preserves, dried fruits, and liquors, in productive rivalry with its neighbor the vineyard. I have an impression that such an orchard will be even more profitable than the vineyard, especially if the mining population of the colony shall, like that of Devonshire and Cornwall, take a liking for cider and perry, and if fruit wines and brandies shall come into general consumption. As the tamarind, the date, the chesnut, and the walnut grow to a large size, it may answer a double purpose if they are planted in the pastures as shade and shelter trees, and yield their orchard room to more portable trees. I find in my notebook a statement (on the authority of Widdington, who wrote on the agriculture of Spain) that the chirimoya, a tropical fruit, comes to perfect maturity in the open gardens of Motril, in Spain; a cheering piece of intelligence to the agriculturists of Victoria, for if such a fruit has become naturalized in Spain, it and many other tropicals may be expected to succeed in North Victoria.

I assign the allotment numbered 4 to the following purposes: a tea shrubbery, a coffee plantation, a sugar plantation, and a hop ground, in such proportions as shall be found most in accordance with the views of the cultivator. I was much pleased with the improved appearance which the climate of France had given to some English hops in the neighborhood of Fontainbleau, and I am impressed with the belief that Victorian hop grounds will surpass in yield and profit those of England. Relief from the heavy

English duty is a direct premium to the Victorian grower. Coffee and sugar may, perhaps, have to be relinquished in South Victoria, except in favorable locations, but there can be no question as to tea and hops; probably coffee and sugar will in the sequel become staple products of North Victoria, and hops and tea of the southern districts.

On revising for the press, I embrace the opportunity of introducing the following additional remarks on the culture of this allotment.

Coffee is very susceptible of frost, and must, in South Victoria, have assigned to it very sheltered and choice position. Brazil at present produces half the coffee grown. The consumption of coffee is on the increase, and if its cultivation gets footing in Victorian husbandry, it will, I apprehend, be as a North Victorian product; though, as it is grown in Spain, it ought to be tried, on a small scale, in favored localities of South Victoria.

Tea may be successfully grown in either division of Victoria, and it will be advisable to have a small plantation on every domain, because it is not only a portable article, but it is also one which does not spoil should the market happen to be otherwise than immediate. I am, however, impressed with the notion that very extensive tea culture is not advisable in Australia, because when the Chinese and the Japanese become sensible enough to see their own interests, they will extend the production of their own peculiar commodity; and there being no doubt of their ability to tea the world, and to produce tea at less cost (by reason of their command of cheap labor) than Australians can at all events for many years to come; and as I have an impression also, that by the time Australians are in a condition to compete with China and Japan, in the European market, they will find the true China plant universally introduced into European shrubberies and pleasure grounds, as a half useful and half ornamental shrub wherever it will thrive, a circumstance which will help to keep the price of tea low.

Saccharine produce has become so essential an article of civilized consumption, that every known mode of *Sugar culture* ought to have trial in Victoria. Hitherto the cane of the east, the maple of the west, and the beet-root of Europe have been the plants chiefly cultivated for sugar; but I apprehend the vegetable world has other plants to offer for sugar production, and that Australian husbandry will have a wide saccharine range. It ought to be cheering to Australians to know that in the West Indies, which have long been called par excellence the sugar colonies, the cultivation of sugar was an introduction by the Spaniards from Europe; though there is ground for supposing that some plant which produced sugar was there indigenous.

The sugar-cane is propagated by laying cuttings or slips of the cane horizontally. There are four varieties cultivated in America, viz., the African, the Otaheite, the West Indian, and the ribband cane. The Otaheite grows luxuriantly, and ripens earlier than the West Indian, but it does not contain so much saccharine matter as the other kinds. The ribband cane is a new variety. It abounds in saccharine juice, and does not require so

long a season for ripening as the other kinds, and it admits of American cultivation two degrees further north than any other kind. The sugar-cane is a comparatively hardy plant, and is cultivated much in the same way as maize, which it resembles when growing. The abundance of the crop depends upon the number of joints that ripen before the frost, so as to allow the saccharine juice to granulate to sugar. A slight frost favors the fermentation which is necessary to the formation of sugar from the sap, though a severe frost destroys the vegetation of the cane. The crop when growing has a beautiful appearance. The sap is so rich in the stalk of the cane as to have almost the consistence of syrup, and sugar exists there as nearly in a complete state as it can be in solution. An acre properly managed will yield a hogshead of 1200 pounds. A sugar establishment is necessarily expensive, by reason of its need of houses and mills where the plantation is large. It has, however, been found that sugar can be grown profitably on a small scale, and without extraordinary capital, and I have therefore determined on including its production, to a given extent, as part of domain culture; leaving it to capitalists to establish an extensive plantation system conjointly with the production of cotton in large areas.

The pine-apple, to which I shall afterwards advert, abounds in saccharine matter, of fine aroma, which would, I apprehend, yield much more sugar than the best French beet. Some attention is due, in Australian husbandry, to the saccharine secretion known as Australian manna, yielded by the eucalyptus viminalis, and also to the exudation, resembling raw sugar, which occasionally incrusts the bark of the myoporum platycarpum. I suspect, in regard to the pine-apple, that it will acquire an ad valorem value of its own greatly above a mere sugar price. Sugar succeeds best with a mean temperature of 77°, but it may be cultivated with advantage when the mean is not under 67°. No product, however, makes so grateful a return for heat as saccharine matter, in whatever shape it is produced The sorghum saccharatum is sufficiently hardy to thrive in South Victoria, and as it yields both sugar and cattle food, it is in consequence a very valuable product. Four centuries ago sugar was only used as a medicine, and could only be purchased by the ounce from an apothecary; whereas in the year 1828 the production was 441,300 tons, of which nearly half was the growth of the British West Indies alone; and that production had in the twenty-two years which elapsed between the years 1828 and 1850, augmented so as to yield, for the latter year, the almost trebled quantity of 1,243,000 tons. Tea, and some other oriental productions may, in the course of years, be superseded in use by some other product, or become of limited demand; but saccharine matter is so essential in every department of domestic economy, and its refuse is so valuable for the feeding of cattle, that it is sure to be a staple product wherever soil and climate are congenial to its growth. I am impressed with the belief that if proper care is evinced in the selection of adapted localities, and they are prepared by skilful drainage and subsoiling operations, and are accompanied by irrigation so as to urge on vegetation at critical stages of growth, there will be found a sufficiency of sunshine, at all events in a North Victorian climate, not only for the profitable cultivation of cane-sugar, but also for that of many tropical and sub tropical pro-

ductions on which Victorian cultivators have not as yet reckoned. Cane-sugar will, I apprehend, be most profitably cultivated in plantations of a square mile each, in alternation with cotton plantations of a like extent, as outlying parts of domain management, in cases where super energy and capital happen to lead in that direction.

Hops, as a Victorian product, stand very high in my estimation. The soil and the climate of South Victoria are so admirably adapted for the hop, that the sooner it is introduced into Victorian husbandry the better. Frost, the arch-enemy of the English hop, is not severe enough in Victoria to do harm; and the only adverse influence of which I am apprehensive is atmospherical turmoil. I have however placed the hop plantation on the east side of the domain, for the purpose of being as well screened as may be from hot winds and their devastating dusts, and it must have especial screening on its west and north sides—perhaps the young larches, ashes, and oaks, to which I shall advert as wanted for hop-poles, cannot be better placed than as a plantation screen for the hops which they are predestined afterwards to uphold. I have to observe that though the hop was indigenous in England, the cultivated variety was probably an introduction from the Netherlands, for the name is of Dutch origin. Strong cloth has been manufactured from the fibres of the hop vine, and in spring time country people, in some hop growing districts, dress young buds of the hop in the manner of asparagus, and consider them an agreeable vegetable. These circumstances enhance the value of the plant, and as the colony has, as I have before remarked, the control of its own excise duties, it will be in the power of its legislature to confer on its hop grower the great boon of exemption from an onerous tax, which amounts to £17 12s. 9½d per ton.

The four foregoing products, of coffee, tea, sugar, and hops, will well occupy the special culture allotment, numbered 4. If the domain is located in South Victoria I should apportion the cropping thus:—hops, twenty acres; tea, three acres; sorghum and other cane-sugar, one acre; coffee, half an acre; hop pole screen plantation, one acre; and a row of sugar maples, within the boundary avenue, half an acre. But if the domain is located north of the 37th parallel, I should then apportion the cropping of the allotment thus:—cane-sugar, twenty acres; coffee, four acres; tea, one acre; and hops, one acre.

I assign the allotment numbered 1 for groves—of the nopal cactus, as cochinella food; of olives and other oil-producing shrubs and trees; of pepper vines; of carob trees; of indigenous trees and shrubs found worthy of culture, either as commercial products or for economical use, as, for instance, the Australian india-rubber tree and the cabbage palm; of groves of senna trees, camphor trees, tallow trees, American india-rubber trees; of all the medicinal shrubs and trees which will pay for cultivation; and of cork oaks, and the best wood for cooperage use. It was my intention to have enumerated several other trees and shrubs which

yield produce of great value, and which I think will thrive in Victoria; but as this is an essay only, and not a treatise, and as I have instanced sufficient to show the class of products assigned to this allotment, and to indicate the range of the special culture department, I shall for the present forego that enumeration.

On revising for the press I have to add, that the *olive*, to which I shall in South Victorian domains appropriate ten acres of the special culture allotment numbered 1, (though in those of North Victoria I shall only appropriate five acres, because I think northern sunshine may be more profitably applied on tree and shrub products which cannot be so well ripened in South Victoria) is so truly a warm climate essential, and has been so long a favorite and a paying product in Italian, Spanish, and French husbandry, that it has, in my estimation, a right to proportionate position in that of Australia. In addition to the products before mentioned I may instance various species of cotton which reach tree dignity, and are in consequence to be cultivated as perennials, as proper to have growing space in this allotment, as also white mulberry trees as silkworm food, in case the private road of the domain shall be insufficient for the supply, or other trees are preferred as vine supporters.

There being many valuable products of field culture which cannot be taken in an annual rotation, because they would stop the onward move of the course, I assign the special culture allotment, numbered 22, for such products. The pine apple, for instance, which in a genial climate requires only the simple culture of a Swede turnip, and propagates itself profitably for ten years by offsets, is a crop in point. For its abundance of saccharine matter and the flavor of its fruit, and for the fibre of its leaves, which, in China, is manufactured into cloth, the pine apple is a very valuable product, and deserves the early attention of the Australian cultivator as a field crop. It is hardier than is generally supposed. The varieties of the onion which have the faculty of offset reproduction, and such other edibles as have that faculty—biennials, triennials, and sub-perennials deemed sufficiently important for occasional culture; madder and cassava, which each require three years for profitable cropping; the dye plants, saffron, weld, woad, and indigo; poppies for opium, tobacco, rhubarb, arrowroot, cardamon, liquorice, and ginger; anise, coriander, caraway, and such other seeds as may be in commercial request; lavender, burnet, sainfoin, New Zealand flax and other textiles, and also cotton of sub-perennial habits

of growth, and teazles, all occur to me as deserving admission into this allotment, in which they may be indulged in a little rotatory cycle among themselves, and have the advantage of change of ground without interfering with the great eight years' course of the domain.

The private road will, in fact, become a grove of white mulberries as silk-worm food, and their supported vines will profitably supplement the vineyard yield.

A garden of six acres will form an important part of the homestead, and as variation in aspect may be of great service in the acclimating of new introductions, I shall suggest the placing of the garden in borders round the homestead, as I have marked on the plan; and because the introduction of warm-climate products will, in Australia, exceed in number and importance other garden products and objects, I have assigned greater width to the northern border on that account. Every intelligent agriculturist is also a horticulturist; and it will be highly commendable to endeavor the union of the two departments of culture in the Australian colonies. Goody Hortulana is a fitting spouse for a Victorian Adam, but I must caution the stripling against the blandishments of a syren who delights in raree shows and fetes, wastes time and money in showy trivialities, and assumes occasionally in placards and newspapers the name of a matron of sterling dignity to which the bedizened syren has no pretence. I may with propriety designate not only the garden management of the homestead, but also the management of the whole 159 acres assigned to the special-culture department of the domain, as a system of horticulture united to the agriculture of Victoria.

On revising for the press in June, 1861, I avail myself of the opportunity to introduce a few remarks on the culture and management of *timber trees*, which, in consequence of their having been long recognized as a branch of British husbandry, and timber products being of great importance in commercial communities, fall properly into the special culture department of my system; and this I do willingly, because I hold it to be the duty as well as the interest of the owner of a domain to keep up a supply of timber proportionate to the extent of that domain, and because also, as timber requires many years for maturity, and great mischief to the community might ensue if its growth was neglected. I have also to urge that in the case of Australian grantees, I consider participation in the supply of timber, growing in a Colony when it became a British possession, as

having created in consideration of value received a trust for posterity to keep up that supply; and in doing so I shall advise the intermixture of British and European, Asiatic, Australasian, African, and American trees, among the best of those which happen to be indigenous to Australia. As a Victorian domain of 640 acres is a very different thing from a little English farm, and as the circumstances of the two countries are so contrariwise affected as to atmospherical condition, I shall not hesitate to advise the planting of the four miles of the boundary fence of the domain with what in England would be called hedge-row timber. Few Englishmen will deny that the hedge-row trees of England have in the main added much to its picturesque beauty, and to the charm of English scenery; though it must be admitted that hedge-row trees in England are in many cases in excess, and in some very detrimental to the interests of rent paying tenants. The climate of England, moreover, is moist, and the intervention therefore of thickly timbered hedge-rows round small inclosures interrupts that free circulation of air which is absolutely necessary to dry a saturated soil in a country where the evaporative process is sluggish in the extreme; but in Australia the climate is so dry that that process is faultily quick, and in nine cases out of ten requires counteraction; moreover, as it is likely that for generations to come the owner and the occupant of a domain will be the same personage, an English tenant's case of hardship will not apply. The shade resulting from avenues of forest trees along road sides will be very agreeable to travellers, and will not only act beneficially on the climate by inducing moisture and atmospherical reciprocation in the interchange of oxygen for nitrogen, but it will screen the interior of the domain from much of the atmospherical turmoil of the hot winds and their damaging dusts, evils to which the Australian colonies are liable. Timbered land, and especially that which abounds in deciduous and large leaved trees, by attracting and condensing moisture from the atmosphere in warm weather exercises a beneficial effect in its locality, it being an ascertained fact that extensive forests influence the descent of rain by their attractive power on passing clouds, and of course a well timbered domain will to a given extent exercise a similar influence; and considering also the reciprocal benefit of salubrity in the atmosphere derivable from a commingling of animal and vegetable respiration in a warm climate, it is obvious that the production of timber should be encouraged by every well organized community and form part of its husbandry, even apart from questions of profit and utility. The Americans are beginning to find out that they have been too lavish of their wood, and that timbered land is in some positions of greater value than that which has been cleared at great cost, and that they have moreover done climate mischief in some localities. Plantations of larch, ash, and oak, which in a young state have been found to answer in England better than others for hop poles, and I have no doubt will answer equally well as supporters of vines and of other tendril plants grown in Australia; may have an acre plot of the special culture allotment numbered 4 assigned to them, where they will be near their place of use. The mountain ash to which the late Mr. Wedgwood, of Maer, son of the great potter, called my attention, as the best of all English woodland produce for pottery

crates, happens to be also well adapted for barrel hoops, and as I happen in consequence of his advice to have planted it extensively in some plantations which I made thirty years ago, in the neighborhood of the Staffordshire potteries, I can bear testimony to the great profit at which it speedily arrived, to its beauty and use as ornamental underwood in game preserves, and to the supply of winter food which its berries yielded to several valuable English birds, which will probably ere long yield to Australians the tribute of song in exchange for an English diet. As pottery ware and even porcelain works of art will in due time become Australian manufactures as a consequent of the fine quality of Australian clay, a matter which was tested by the elder Wedgwood, in the medallion, of which an engraving is given on the title page of Governor Phillip's voyage to Botany Bay, published in 1790, about which Mr. Wedgwood, the son, on presenting me with a medallion portrait of his father, made from the same clay, told me that his father had said that he had never seen any article of China manufacture which equalled as to material the Botany Bay clay, and which he therefore predicted would become a valuable import from the Colony. Though it may be long before the master mind of a Victorian Wedgwood shall Prometheus like breathe artistic life into Victorian clay, and send it to vie with the art creations of England, Sevres, and Dresden, &c., it may be well to be providing crate wood and barrel hoops, so that no inconvenience may be felt when those articles come into actual demand, and that is why I have gone out of my way to mention the medallions and to advise the planting of mountain ash as a useful tree. Planted half a chain asunder, the boundary fences will afford space for 640 trees, and I would specially instance as worthy of place among them the blue gum of the colony, the cork oak, the English ship building oaks, and such of the oaks of America as bear the best edible acorns, or are the best adapted for ship building, the red cedar, and the Kauri pine of East Australia, the Norfolk Island and New Zealand pines, and the best of the pine family generally ; together with a selection from such of the timber trees as well of Australia as of other countries, as are suitable for a protecting screen against the hot winds, in order to combine protection with ornament and profit. Many ashes and mountain ashes, oaks of the lesser varieties, limes, larches, elms, and other useful trees, and especially such as are best adapted for casks and cooperage use, which are likely hereafter to be in great demand, may be planted at the distance of a chain from each other along the west fences, of numbers 8, 9, 14, 16, 17, and 22, as hedge-row trees, where they will be productive of good by yielding shade, as the sun happens to be east or west of the pastures ; the north and east fences of number 19 may be devoted to New Zealand flax, and to osiers and willows, &c., which delight in moisture and will pay well for growing.

Shade and shelter trees dispersed over the range of pasture lands, after the rate of a tree per acre, will give to them a park-like appearance, and will aid materially in checking evaporation. Trees which answer two purposes will of course be preferred, and I would instance tamarinds, date palms, cabbage palms, milk trees, bread fruit trees, cocoa nut palms, cacao nut trees, cashew nuts, walnuts, and chesnuts, Peruvian bark, and service

trees, the bombax ceiba, alluded to in cotton culture, cedars, horse chesnuts, locust trees, beeches, Chili pines, Norfolk Island pines, Weymouth pines, silver firs, and oriental and occidental planes as particularly worthy of place in this parkish district; and of course if there should happen to be any indigenous trees or promising saplings growing on it they will be allowed to remain, though I contemplate the complete clearance of timber from the arable land, and from that assigned to the special culture department. I may remark, that in my annual visits to London for many years, I noticed that planes throve the best of any of the trees planted in the city squares and gardens, and seemed to relish their position. I never heard this accounted for, but the fact is certain; and after it had attracted my notice I made a point of examining every planted square I fell in with, whether it was at the west end, the east end, or on the Surrey side of the city, and I invariably found planes to be the most thriving of the trees, and next to them their kindred tree, the sycamore. I mention the circumstance as a hint to Australian citizens, that both varieties of the plane appear from that peculiarity to be proper for trial in their city squares, avenues, and pleasure grounds; both have the merit of being umbrageous, which is a greater object in Australian cities than in London Limes are the best of all English trees for avenues, and I used to be delighted when in England at the immense number of bees which at sunrise in summer were always findable gathering honey from the opening flowers of the lime; where therefore bees are kept lime trees have an additional value.

The acclimating of plants and the introduction of new varieties are so important in the infantine state of Australian husbandry, that I deem the subject worthy of a few special remarks, or rather of a series of extracts; for I shall, on these subjects, prefer presenting the observations of others rather than my own, because I am myself partial to fountain-head authority in experimental matters.

The acclimating pliability of nature is well illustrated by Dr. Thomson, of Edinburgh, in his treatise on brewing and distillation, by the remark that the cuticle of Norfolk barley is thinner than that of East Lothian barley, but that when Norfolk barley is sown in Scotland for several successive years its cuticle, in consequence, becomes thicker than it was at its introduction.

Phillips, in his History of Cultivated Vegetables, makes this pertinent observation: "It is worthy of remark that two vegetables of so much consequence in the commerce of Jamaica as the coffee tree and the sugar cane should have found their way to that hot climate through the temperate zone of Europe, where they could never have arrived at perfection. The coffee tree was planted at Fulham, in Middlesex, fourteen years before it was known in Jamaica; and the sugar cane was planted in England fifty years previously to its being cultivated in that island, which may now be justly styled the London sugar and coffee garden."

The celebrated Dr. Priestley, in a letter to Sir John Sinclair, as president

of the English Board of Agriculture, written in 1797, and published in the first volume of the communications to that board, thus speaks of Mr. Joseph Cooper, an American farmer, of the neighborhood of Philadelphia, who may be cited as the type of a class of men much wanted in Australia, in the present stage of its husbandry: "He thought," said Priestley, "philosophically on his subject, and had had extraordinary success in a variety of plans which were then wholly new, and which promised to be of great benefit to his country and the world."

The doctor's letter is not a long one, and as it gives us a glance at American culture a century ago, when it was but little in advance of that which now obtains in Australia, I shall introduce more of it than I at first intended, because of its thoughtful good sense and its exemplifying my belief that thoughtful heads will be a greater acquisition to Australia than even horny hands, notwithstanding the premium price which the latter appear inclined to forestall. The observations of Mr. Cooper are, in fact, a little manual in their way; and though I do not subscribe without some reservation to all his conclusions, and think that he carries his theory in regard to change of seed and of plants beyond a judicious verge, there is nevertheless much to the point in all his observations.

"I have," writes Priestley, "Mr. Cooper's leave to communicate to you his observations and experiments relating to an opinion and practice which has prevailed, I believe universally, but which he is satisfied is ill founded. Plants, it is said, will degenerate unless the soil in which they grow be changed. It is therefore thought to be necessary from time to time to get fresh seeds and roots, &c. from distant places. Mr. Cooper, on the contrary, has for many years been in the habit of selecting the best seeds and roots of his own; and though he has continually sown and planted them in the same soil, every article of his produce is greatly superior to those of any other person who supplies this market, and they seem to be still in a state of improvement. This, without his knowing it, is the very same plan that was adopted by Mr. Bakewell, in England, with respect to animals. He kept improving his breeds by only coupling those in which the properties he wished to produce were the most conspicuous, without any regard to consanguinity, or to any other circumstance whatever.

"Mr. Cooper was led," adds Priestley, "to his present practice, which he began more than forty years ago, by observing that vegetables of all kinds were very subject to change with respect to their time of coming to maturity, and other properties, but that the best seeds never failed to produce the best plants. Among a great number of experiments he particularly mentions the following:—

"About the year 1746, his father procured seeds of the long watery squash, and though they have been used on the farm ever since that time, without any change, they are at this time better than they were at the first.

"His early peas were procured from London in the year 1756; and though they have been planted on the same place every season, they have been so far from degenerating that they are preferable to what they were then. The seeds of his asparagus he had from New York in 1752, and

though they have been treated in the same manner, the plants are greatly improved.

"It is more particularly complained, that potatoes degenerate when they are planted from the same roots in the same place. At this Mr. Cooper says he does not wonder, when it is customary with farmers to use the best, and plant from the refuse; whereas, having observed that some of his plants produced potatoes that were larger, better shaped, and in greater abundance than others, he took his seed from them only; and the next season he fouud that the produce was of a quality superior to any that he had ever had before. This practice he still continues, and finds that he is abundantly rewarded for his trouble.

"Mr Cooper is also careful to sow the plants from which he raises his seed at a considerable distance from any others. Thus, when his radishes are fit for use, he takes ten or twelve that he most approves, and plants them at least one hundred yards from others that blossom at the same time. In the same manner he treats all his other plants, varying the circumstances according to their nature.

"About the year 1772, a friend of his sent him a few grains of a small kind of Indian corn, not larger than goose shot, which produced from eight to ten ears on a stalk. They were also small, and he found that few of them ripened before the frost. Some of the largest and earliest of these he saved, and planting them between rows of a larger and earlier kind, the produce was much improved. He then planted from those that had produced the greatest number of the largest ears, and that were the first ripe; and the next season the produce, with respect to quality and quantity, was preferable to any that he had ever planted before. From this corn he has continued to plant ever since, selecting his seed in the following manner:—

"When the first ears are ripe enough for seed, he gathers a sufficient quantity for early corn, or for replanting, and at the time that he wishes his corn to be generally ripe, he gathers a sufficient quantity for the next year's planting; having particular care to take it from stalks that are large at the bottom, of a regular taper, not very tall, the ears set low, and containing the greatest number of good sizable ears, and of the best quality; these he dries quickly, and from them he plants his main crop; and if any hills be missing, he replants from the seeds that were first gathered, which he says will cause the crops to ripen more regularly than they commonly do, and which is of great advantage. This method he has practised many years, and he is satisfied that it has been the means of increasing the quantity and improving the quality of his crops beyond what any person who had not tried the experiment could imagine.

"Farmers differ much with respect to the distance at which they plant their corn, and the number of grains they put in a hill. Different soils, Mr. Cooper observes, may require different practices in both these respects; but in every kind of soil that he has tried, he finds that planting the rows six feet asunder each way, as nearly at right angles as may be, and leaving not more than four stalks in a hill, produces the best crop. The common method of saving seed corn, by taking the ears from the heap, is attended, he says, with two disadvantages; one is the taking the largest ears, of

which in general only one grows on a stalk, which lessens the produce; and the other is taking ears that ripen at different times.

"For many years Mr. Cooper renewed all the seed of his winter grain from a single plant, which he had observed to be more productive, and of a better quality than the rest, which he is satisfied has been of great use. And he is of opinion, that all kinds of garden vegetables may be improved by the methods described above, particular care being taken that different kinds of the same vegetables do not bloom at the same time near together, since by this means they injure one another.

"It is alleged, that foreign flax-seed produces the best flax in Ireland; but Mr. Cooper says, that when it is considered that only the bark of the plant is used, and that this is in perfection before the seed is ripe, it will appear that his hypothesis is not affected by it.

"Mr. Cooper had the following instance of the naturalization of a plant in a different climate:—He had some water-melon seed sent to him from Georgia, which he was informed was of a peculiarly good quality; knowing that seeds from vegetables which grow in a hot climate require a longer summer than that of Pennsylvania, he gave them the most favorable situation that he had, and used glasses to forward their growth, and yet few of them ripened well. But finding them to be of an excellent quality, he saved the seeds of those that ripened the first; and by continuing this practice five or six years, they came to ripen as early as any that he ever had."

We have now the deductions of the great vegetable physiologist, Thomas Andrew Knight, for our guidance; and I was so much struck with the harmony between the "thought" of Cooper and the "science" of Knight, as exhibited in the foregoing quotation, and in that which I am about to extract from Knight, that I thought it desirable to introduce both, as corroborative of each other on a subject of so much importance in the present stage of the agriculture and horticulture of Australia.

"Nature," writes Knight, in a paper read before the Horticultural Society of England, in 1806, "has given to man the means of acquiring those things which constitute the comforts and luxuries of civilized life, though not the things themselves; it has placed the raw material within his reach; but has left the preparation and improvement of it to his own skill and industry. Every plant and animal, adapted to his service, is made susceptible of endless changes, and, as far as relates to his use, of almost endless improvement. Variation is the constant attendant on cultivation, both in the animal and vegetable world; and in each the offspring are constantly seen, in a greater or less degree, to inherit the character of the parents from which they spring.

"No experienced gardener can be ignorant that every species of fruit acquires its greatest state of perfection in some peculiar soils and situations, and under some peculiar mode of culture: the selection of a proper soil and situation must therefore be the first object of the improver's pursuit; and nothing should be neglected which can add to the size, or improve the flavor of the fruit from which it is intended to propagate. Due attention to these

points will in almost all cases be found to comprehend all that is necessary to insure the introduction of new varieties of fruit, of equal merit with those from which they spring; but the improver, who has to adapt his productions to the cold and unsteady climate of Britain, has still many difficulties to contend with; he has to combine hardiness, energy of character, and early maturity, with the improvements of high cultivation. Nature has, however, in some measure pointed out the path he is to pursue; and, if it be followed with patience and industry, no obstacles will be found, which may not be either removed, or passed over.

"If two plants of the vine or other tree of similar habits, or even if obtained from cuttings of the same tree, were placed to vegetate, during several successive seasons, in very different climates; if the one were planted on the banks of the Rhine, and the other on those of the Nile, each would adapt its habits to the climate in which it were placed; and if both were subsequently brought, in early spring, into a climate similar to that of Italy, the plant which had adapted its habits to a cold climate would instantly vegetate, whilst the other would remain perfectly torpid. Precisely the same thing occurs in the hot-houses of this country, where a plant accustomed to the temperature of the open air will vegetate strongly in December, whilst another plant of the same species, and sprung from a cutting of the same original stock, but habituated to the temperature of a stove, remains apparently lifeless. It appears, therefore, that the powers of vegetable life, in plants habituated to cold climates, are more easily brought into action than in those of hot climates; or, in other words, that the plants of cold climates are most excitable: and as every quality in plants becomes hereditary, when the causes which first gave existence to those qualities continue to operate, it follows that their seedling offspring have a constant tendency to adapt their habits to any climate in which art or accident places them.

"But the influence of climate on the habits of plants will depend less on the aggregate quantity of heat in each climate, than on the distribution of it in the different seasons of the year. The aggregate temperature of England, and of those parts of the Russian Empire that are under the same parallels of latitude, probably does not differ very considerably; but, in the latter, the summers are extremely hot, and the winters intensely cold; and the changes of temperature between the different seasons are sudden and violent. In the spring great degrees of heat suddenly operate on plants which have been long exposed to intense cold, and in which excitability has accumulated during a long period of almost total inaction: and the progress of vegetation is in consequence extremely rapid. In the climate of England the spring, on the contrary, advances with slow and irregular steps, and only very moderate and slowly-increasing degrees of heat act on plants in which the powers of life have scarcely in any period of the preceding winter been totally inactive. The crab is a native of both countries, and has adapted alike its habits to both; the Siberian variety introduced into the climate of England retains its habits, expands its leaves, and blossoms on the first approach of spring, and vegetates strongly in the same temperature in which the native crab scarcely shows signs of life; and its fruit acquires

a degree of maturity, even in the early part of an unfavorable season, which our native crab is rarely or never seen to attain.

"Similar causes are productive of similar effects on the habits of cultivated annual plants; but these appear most readily to acquire habits of maturity in warm climates; for it is in the power of the cultivator to commit his seeds to the earth at any season; and the progress of the plants towards maturity will be most rapid where the climate and soil are most warm. Thus, the barley grown on sandy soils, in the warmest parts of England, is always found by the Scotch farmer, when introduced into his country, to ripen on his cold hills earlier than his crops of the same kind do, when he uses the seeds of plants, which have passed through several successive generations in his colder climate; and in my own experience, I have found that the crops of wheat on some very high and cold ground, which I cultivate, ripen much earlier when I obtain my seed-corn from a very warm district and gravelly soil, which lies a few miles distant, than when I employ the seeds of the vicinity.

"The value, to the gardener, of an early crop, has attracted his attention to the propagation and culture of the earliest varieties of many species of our esculent plants; but in the improvement of these he is more often indebted to accident than to any plan of systematic culture; and contents himself with merely selecting and propagating from the plant of the earliest habits which accident throws in his way, without inquiring from what causes those habits have arisen: and few efforts have been made to bring into existence better varieties of those fruits which are not generally propagated from seeds, and which, when so propagated, of necessity exercise, during many years, the patience of the cultivator before he can hope to see the fruits of his labor.

"The attempts which I have made to produce early varieties of fruit are, I believe, all that have yet been made; and though the result of them is by no means sufficiently decisive to prove the truth of the hypothesis I am endeavoring to establish, or the eligibility of the practice I have adopted, it is amply sufficient to encourage future experiment.

"The first species of fruit which was subjected to experiment by me was the apple; some young trees of those varieties of this fruit, from which I wished to propagate, were trained to a south wall, till they produced buds which contained blossoms. Their branches were then, in the succeeding winter, detached from the wall, and removed to as great a distance from it as the pliability of their stems would permit, and in this situation they remained till their blossoms were so far advanced in the succeeding spring as to be in some danger of injury from frost. The branches were then trained to the wall, where every blossom I suffered to remain soon expanded and produced fruit. This attained in a few months the most perfect state of maturity; and the seeds afforded plants, which have ripened their fruit very considerably earlier than other trees, which I raised at the same time, from seeds of the same fruit, which had grown in the orchard. *In this experiment the fecundation of the blossoms of each variety was produced by the farina of another kind, from which process, I think, I obtained in this and many similar experiments an increased vigor and luxuriance of growth*; but I have no reasons

whatever to think that plants thus generated ripen their fruit earlier than others which are obtained by the common methods of culture. I must, therefore, attribute the early maturity of those I have described to the other peculiar circumstances under which the seeds and fruit ripened from which they sprang.

"I obtained, by the same mode of culture, many new varieties, which are the offspring of the Siberian crab and the richest of our apples, with the intention of affording fruits for the press, which might ripen well in cold and exposed situations. The plants thus produced seem perfectly well calculated in every respect to answer the object of the experiment, and possess an extraordinary hardiness and luxuriance of growth. The annual shoots of some of them, from newly grafted trees in my nursery, the soil of which is by no means rich, exceeded six feet and a half in height in the last season; and their blossoms seem capable of bearing extremely unfavorable weather without injury. *In all the preceding experiments some of the new varieties inherited the character of the male, and others of the female parent in the greatest degree; and of some varieties of fruit (particularly the golden pippin) I obtained a better copy by introducing the farina into the blossom of another apple, than by sowing their own seeds;* I sent a new variety (the Downton pippin) which was thus obtained from the farina of the golden pippin, to the Horticultural Society last year; but those specimens afforded but a very unfavorable sample of it, for the season, and the situation in which the fruit ripened, were very cold, and almost every leaf of the trees had been eaten off by insects. In a favorable season and situation it will, I believe, be found little, if at all, inferior to the golden pippin, when first taken from the tree; but it is a good deal earlier, and probably cannot be preserved so long.

"I proceed to experiments on the grape, which, though less successful than those on the apple in the production of good varieties, are not less favorable to the preceding conclusions. A vinery in which no fires are made during the winter affords to the vine a climate similar to that which the southern parts of Siberia afford to the apple or crab-tree: in it a similarly extensive variation of temperature takes place, and the sudden transition from great comparative cold to excessive heat is productive of the same rapid progress in the growth of the plants, and advancement of the fruit to maturity. My first attempt was to combine the hardiness of the blossom of the black cluster, or Burgundy grape, with the large berry and early maturity of the true sweetwater. The seedling plants produced fruit in my vinery at three or four years old, and the fruit of some of them was very early; but the bunches were short and ill-formed, and the berries much smaller than those of the sweetwater, and the blossoms did not set by any means so well as I had hoped.

"Substituting the white chasselas for the sweetwater, I obtained several varieties whose blossoms appear perfectly hardy, and capable of setting well in the open air; and the fruit of some of them is ripening a good deal earlier in the present year than that of either of the parent plants. The berries, however, are smaller than those of the chasselas, and with less tender and delicate skins; and, though not without considerable merits for the dessert, they are generally best calculated for the press: for the latter purpose, in a

cold climate, I am confident that one or two of them possess very great excellence. I sent a bunch of one of those varieties to the Horticultural Society in the last autumn, and I propose to send two or three others in the present year.

"I have subsequently obtained plants from the white chasselas and sweetwater, whose appearance is much more promising; and the earliest variety of the grape I have ever yet seen sprang from a seed of the sweetwater and the farina of the red frontignac. This is also a very fine grape, resembling the frontignac in color and the form of the bunch; but I fear its blossoms will prove too tender to succeed in the open air in this country; a single bunch, consisting of a few berries, is, however, all that has yet existed of this kind. The present season also affords me two new varieties of the vine with striped fruit and variegated autumnal leaves, produced by the white chasselas and the farina of the Aleppo vine: one of these has ripened extremely early, and is, I think, a good grape. When perfectly ripe, I propose sending a bunch of it for the inspection of the Horticultural Society.

"In all attempts to obtain new varieties of fruit, the propagator is at a loss to know what kinds are best calculated to answer his purpose; and therefore I have mentioned those varieties of the grape from which I have propagated with the best prospect of success. My experiments are, however, still in their infancy; and I do not possess the means of making them on so large a scale or in so perfect a manner as I wish; nevertheless, the facts of which I am in possession leave no grounds of doubt in my mind, that varieties of the grape, capable of ripening perfectly in our climate when trained to a south wall, and of other fruits better calculated for our climate than those we now cultivate, may readily be obtained; but whether the mode of culture I have adopted and recommended be most eligible must be decided by future and more extensive practice.

"I have made experiments similar to the preceding on the peach; but I can say no more of the result of them, than that the plants possess the most perfect degree of health and luxuriance of growth, and that their leaves afford satisfactory evidence of the good quality of the future fruit. I am ignorant of the age at which plants of this species become capable of producing blossoms; but the rapid changes in the character of the leaves and growth of my plants, which are now in their third year, induce me to believe that they will be capable of producing fruit at three or four years old.

"I shall finish my paper with stating a few conclusions, which I have been able to draw in the course of many years' close attention to the subject on which I write.

"*New varieties of every species of fruit will generally be better obtained by introducing the farina of one variety of fruit into the blossom of another, than by propagating from any single kind. When an experiment of this kind is made between varieties of different size and character, the farina of the smaller kind should be introduced into the blossoms of the larger; for, under these circumstances, I have generally (but with some exceptions) observed in the new fruit a prevalence of the character of the female parent;* probably owing to the following causes—The seed-coats are generated wholly by the female

parent, and these regulate the bulk of the lobes and plantule; and I have observed, in raising new varieties of the peach, that when one stone contained two seeds, the plants these afforded were inferior to others. The largest seeds, obtained from the finest fruit, and from that which ripens most perfectly and most early, should always be selected. It is scarcely necessary to inform the experienced gardener, that *it will be necessary to extract the stamina of the blossoms from which he proposes to propagate, some days before the farina begins to shed, when he proposes to generate new varieties* in the manner I have recommended.

"When young trees have sprung from the seed, a certain period must elapse before they become capable of bearing fruit, and this period, I believe, cannot be shortened by any means. Pruning and transplanting are both injurious; and no change in the character or merits of the future fruit can be effected during this period either by manure or culture. The young plants should be suffered to extend their branches in every direction, in which they do not injuriously interfere with each other; and the soil should just be sufficiently rich to promote a moderate degree of growth, without stimulating the plant to preternatural exertion, which always induces disease.* The periods which different kinds of fruit-trees require to attain the age of puberty are very varied. The pear requires from twelve to eighteen years; the apple, from five to twelve, or thirteen; the plum and cherry, four or five years; the vine, three or four; and the raspberry, two years. The strawberry, if its seeds be sown early, affords an abundant crop in the succeeding year. My garden at present contains several new and excellent varieties of this fruit,† some of which I shall be happy to send to the Horticultural Society."

The coincidence in thought and in illustration between Cooper and Knight is remarkable; and yet it is evident that both were original. Knight, in illustrating the extremes of heat and cold which plants can endure without injury, has these remarks: "In Jamaica and other mountainous islands in the West Indies, the air upon the mountains becomes soon after sunset chilled and condensed, and, in consequence of its superior gravity, descends and displaces the warm air of the valleys; yet sugar canes are so far from being injured by this sudden decrease of temperature, that the sugars of Jamaica take a higher price in the market than those of the less elevated islands, of which the temperature of the day and night is subject to much less variation." "The mango, (*mangifera Indica*,) though a native of a very hot and bright climate, and capable of bearing, with apparent benefit, the hot drying winds of Bengal, vegetates freely and retains its health in

"* The soil of an old garden is peculiarly destructive."

"† The hautboy strawberry does not appear to propagate readily with the other varieties, and may possibly belong to an originally distinct species. I have, however, obtained several offspring from its farina; but they have all produced a feeble and abortive blossom. If nature, in any instance, permits the existence of vegetable mules (but this I am not inclined to believe), these plants seem to be beings of that kind."

comparatively low temperature, and under a cloudy atmosphere. The plants which I possess sprang from seeds, in October, 1818, and are now, (December, 1819,) shooting strongly, although in a temperature rarely so high as 60°. Mr. Turner, in his Journey to Thibet, states that he found the mango growing in latitude 27° 50′, in Boutan, in the same orchard with the apple tree; the apples ripening in July, and the mangoes in September."

What I am anxious to impress upon Australians in this early stage of their husbandry, is the cultivation of habits of patience and perseverance, along with the cultivation of the products which they wish to introduce, for the exercise of which they will have abundant scope. Dr. Walker has recorded as a curious fact, that though the yew tree is a native of Sweden, all the yew plants sent from Paris to plant Le Notre's designs, died at Stockholm the first winter. My inference from that fact is, that French acclimation had in that instance so revolutionized the French variety as to have unfitted it for direct resumption of habitat in its own connatural country. De Leuze has observed that though it is difficult to form vegetable collections in northern countries, industry conquers obstacles, and the more precautions are necessary to secure plants from the rigor of a climate, the more will culture be perfected; and Loudon has well remarked, that nothing could be more extraordinary in the way of gardening than the well known fact, that though a century ago there was scarcely such a thing in any part of Russia as a garden, there had been for the last fifty years more pineapples grown in the neighborhood of Petersburg than in all other countries of the Continent put together. But my crowning illustration on this subject shall be the record of old Parkinson, that our English ancestors, in the days of Queen Elizabeth, had the patience to reconcile the laurel or bay cherry, which is now as hardy as if had been "a native Briton," to an English habitat, by defending their bantling "from the bitterness of the winter, by casting a blanket over the top thereof!"

Cotton culture being the coronal topping of the aspiring special branch of Australian husbandry, and recent events in America having attached unusual interest to a product likely to be, as an Australian staple, second only in commercial importance to wool, and the culture of that product being unknown in English husbandry, I am induced to go somewhat more into detail as to it than I thought myself called upon to do in regard to any other vegetable product.

Cotton, it is well known, is the wool or down which surrounds the seeds of a plant botanically named *gossypium*, of which the consumption is enormous; and though I have arrived at the conclusion that cotton culture in Victoria will be best experimentally commenced in the sixteen millions of acres situate between the River Murray and the 37th parallel of south latitude, and shall, as a consequence of that conclusion, propound that cotton, as well as cane-sugar, will be most profitably cultivated in plantations in northern Victoria, set apart especially for the purpose, and cropped in alternation with each other: I am nevertheless of opinion that much may be done, as to both products, in favorable locations in other parts

of the colony, as parcel of domain culture; inasmuch as room may be made for such of the perennial varieties of cotton as reach tree dignity in the special culture allotment numbered 1, and for the less permanent varieties, intended to be cultivated as sub-perennials, in the special culture allotment numbered 22, whilst such of the varieties as will submit to strictly annual cropping may pass through the Victorian course, along with sugar beet, in the summer cropping of the field, classed as the sixth in my arable rotation; or along with hemp, flax, and other textiles, in the summer cropping of the field classed as the eighth in that rotation; or along with the cropping of both fields, if demand for cotton shall so require.

The manufacture of cotton into cloth is unquestionably of remote antiquity, though it appears that that of linen preceded it, for it is recorded of Solomon (2 Chronicles i. 16), that his merchants received linen yarn, at a price, from Egypt. There has been much controversy as to whether the wrapping cloths of the Egyptian mummies were made of linen or cotton; but the microscope, in the hands of Dr. Thomson, has demonstrated that the material so used was linen, and not cotton. Herodotus, however, who wrote about 445 years before the Christian era, expressly states that the Indians possessed a plant which, instead of fruit, produced wool, of a finer and better quality than that of sheep, of which they made their clothes; so that cotton culture, and the manufacture to which that culture has given rise, have a clear antiquity of more than two thousand years.

The cotton plant was early grown in Egypt, and also in the island of Tylos, in the Persian Gulf. "In Upper Egypt," writes Pliny, "towards Arabia, there grows a shrub which some call gossypium, and others xylon, and from which the stuffs are made which we called xylina. (Xylon, it is to be observed, was the Greek name of the cotton plant.) It is small, and bears a fruit resembling a nut, within which is a downy wool, which is spun into thread. There is nothing to be preferred to these stuffs for whiteness or softness; beautiful garments are made from them for the priests of Egypt." Pliny, in his description of the island of Tylos, (following the Greek naturalist Theophrastus,) enumerates among its remarkable productions "wool bearing trees," with leaves exactly like those of the vine, but smaller; these trees, he says, bear a fruit, which bursting when ripe, display a ball of downy wool, from which are made costly garments, of a fabric resembling linen.

It is clear also that the manufacture of cotton was in use in Mexico before its conquest by the Spaniards; for history has recorded that Cortes was presented with garments of cotton, and with cotton cloth to cover his huts; and cotton cloth has been discovered among the relics found in their earliest tombs, so that some species of cotton are clearly indigenous in America.

Among the peculiar incidents of cotton culture which I have noted in my researches on the subject, are the revival of that culture in Egypt, by Ali Pasha, in the year 1821, after a discontinuance of fifteen hundred years, and the extraordinary fact, (if fact it be,) that the celebrated Sea Island variety should, after migrating from the East to the West Indies, *viâ* Europe, and becoming famous in the West, re-migrate from the West Indies to its original eastern clime, *viâ* Bourbon, and be received under its

novel name of Bourbon cotton, as an invaluable acquisition to the flora of the very region which gave it birth !

We know nothing earlier of the culture of cotton in Europe, than that it was introduced into Spain from Morocco, by the Moors, in the tenth century, and that it was established in Italy in the fourteenth. The cotton manufactories of England, which are comparatively modern, were long supplied with the raw material from the Levant, and subsequently from the West Indies It is stated, in Wilson's account of the "Province of Carolina, in America," published in 1682, "that cotton of the Cyprus and Malta sort grew well, and a good plenty of the seed was sent thither;" which I quote to show that if the *gossypium barbadense* is in reality identical with the *gossypium herbaceum*, (as Baines intimates, and states that the Sea Island variety was probably of Persian origin,) it is much more likely that the West Indies should have received it, in the progress of colonization, from Persia, *viâ* Cyprus and Malta, than that Persia should have been its recipient from the West Indies.

The general introduction into use of Arkwright's spinning machinery, in 1769; the establishment of the factory system, in 1785; and improvements soon afterwards effected in other machinery and in the arts of bleaching and calico printing; gave, in combination, the astonishing impetus to the cotton manufactures of England, which has resulted in the production of the most wonderful industrial development of all ages and of all countries; and though, in justice to India, I have recorded the true birth place of the cotton manufacture, a patriotic feeling impels the addition, that its majestic growth was wholly due to English nurture.

In the year 1781, the aggregate importation of cotton into Britain from all parts of the world was only 5,198,778 lbs.; but, in 1789, when the American States were intending to participate in cotton culture, it had augmented to 32,576,000 lbs., which were thus supplied:—

	lbs.
British West Indies	10,128,000
French, Spanish, Portuguese, and Dutch colonies ...	15,600,000
Surat and the East Indies	2,000,000
Isle of France and Bourbon	148,000
Smyrna and Turkey	4,700,000
	32,576,000

In the year 1833, the importation of cotton into Britain had augmented to 303,656,837 lbs, of which 33,139,050 lbs. were from the East Indies, being somewhat over the entire supply of the year 1789; which shows that, in the 44 years which had elapsed between the two dates, cotton culture had greatly progressed in India, though not in the surprising ratio at which it had progressed in America; for the American States exported, in 1791, only 19,200 lbs., which was their then entire produce,—the States having at that date no cotton manufacturing establishments of their own: but, in the year 1833, the quantity exported from the States had augmented to 216,000,000 lbs., after retaining 39,000,000 lbs. for the employment of their own looms.

The production of cotton has augmented amazingly since the year 1833, in various parts of the world; but the American States retain the lead which they had then taken, and have, of late years, supplied Britain with six-sevenths of all the cotton manufactured there.

The quantities of raw cotton consumed in the chief manufacturing countries of the world in 1856 (says Simmonds in his *Dictionary of Trade Products*, published at London in 1858) were, *in millions of pounds*, as follow:—Britain, 920; Russia, Germany, Holland, and Belgium (together) 256; France, 211; Spain, 48; countries bordering on the Adriatic, 39; Mediterranean and other countries, 56, and the United States of America, 265;—making a total of 1795 millions of pounds!

The following transmigrations of a small parcel of cotton wool evince the importance of the cotton plant, and the ramifications of the trade to which it has given rise. The parcel, after a voyage from India to London, was sent to Manchester to be manufactured into yarn; after which it made its first appearance in Paisley to be woven; thence it was sent into Ayrshire to be tamboured; after which it made its second appearance in Paisley to be veined; after that it was sent to Dumbarton to be hand sewed; after which it made its third appearance in Paisley, whence it was sent to Renfrew to be bleached; after which it made a fourth appearance in Paisley, whence it was sent to Glasgow to be finished; after which it was despatched by coach to London. The time which intervened between the package of the wool in India and its arrival as cloth in the merchant's warehouse in London, after its many northern excursions, was three years, in the course of which it had travelled five thousand miles by sea, and one thousand by land, and had contributed to the support of one hundred and fifty people, who, however, by their combined efforts, had increased its value full two thousand per cent.!

It luckily happens for Australians that the English East India Company were induced, in 1788, to attempt the extension and improvement of cotton culture in their Indian provinces, where, as I have stated, cotton culture originated, and where the process of manufacture had arrived at such a superlative degree of perfection as that the epithet "a web of woven wind" applied to Dacca muslin, was scarcely hyperbolical, inasmuch as we have the testimony of an English missionary that Dacca muslins were so exquisitely fine that, when laid on the grass and the dew had fallen upon them, they were no longer visible: and also that, simultaneously with the proceedings of the company in India, the introduction of cotton culture was effected in Georgia and Carolina, where, it is to be borne in mind, that culture had not pre-existed. From these simultaneous movements, Australian agriculturists can reap the benefit, as well of the company's experience as of that of the American States also, and can thereby see the importance of care in preparing cotton for the English market; for it was unquestionably owing to the prejudices of the Hindoos against innovation in their antiquated mode of culture and market preparation, and the greater attention of the American planters to the preparative requirements of their English customers (combined with the fortunate incidents of the almost accidental acquirement by the Americans of the Sea Island variety of cotton, and of

the invention in 1793, by Mr. Eli Whitney, of Massachusetts, of an implement called a saw-gin, with which a man could effectually cleanse from seeds and dirt 3 cwt. of cotton in a day, without the injury to its staple which beating in the old way occasioned); whilst Hindoo culture and management remained stationary, that the American plant unexpectedly grew into a giant whilst the East Indian plant, originally of greater promise, got stuntedly dwarfed.

The great cotton district of America comprises the States of Virginia, Carolina, Georgia, Alabama, Mississippi, Louisiana, Tennessee, Arkansas, and Florida, and (overlooking the elongated part of Florida, because it is insufficient in breadth to entitle the mass of the district to claim much in respect of its own southern position), may be considered as lying between the parallels of 30° and 36° north latitude. I have, in an earlier part of this essay, adverted to the statement of Humboldt, that mere latitude is not to be relied upon as an infallible criterion of climate adaptation for particular products, inasmuch as many influences have combined to give to Australian climates great advantage over those of America, which lie in approximate position; and it being admitted in physical geography that the isothermal line which would pass through Australia about latitude 35° would cross America about 30°, it will I apprehend, as a consequence, be found on investigation that, for cotton growing, the soil and climate of the land of Victoria which lies between the 34th and the 37th parallels are as eligible as those which lie between the 30th and the 36th of the North American continent. If climate heat beyond a given degree had been of greater avail than it is in cotton culture, it is obvious that the East Indian plant would have been the giant and the American the dwarf; for all accounts agree that cotton is moderate in its requirements as to moisture, in which alone the American States had the advantage over much warmer East Indian provinces: and though it is true that the best varieties of cotton at present in cultivation which happen to have had a tropical origin are very sensitive to the influence of frost, it does not follow, as an inevitable consequence, that new varieties originating in cooler climates from those tropical originals will, of necessity, retain the extreme temperature susceptibility of their hot climate precursors. The fact is, that the aversion of the Hindoo cultivator to innovation of any kind, and adhesion to an imperfect system of market preparation spoilt the commodity which India produced in greater perfection than America, and thereby threw the immense advantage of a lucrative branch of husbandry into the hands of the Americans exclusively, because they compelled their slaves to attend to the requirements of their English customers, and invented (as we have seen) a saw-gin to perfect a preparation which the East India Company failed to obtain from their coolies with the obsolete machinery which those coolies persisted in using. The consequence was that the better material became, under competition, the half-price article, and the result, in the sequel, was the monopoly by the United States of six-sevenths of the entire supply of Britain, leaving only a single seventh for the produce of India, Brazil, the West Indies, Egypt, and the rest of the world conjointly, a circumstance which, in my mind, indicates great peril in any resort to coolie labor and coolie

management in the introduction of cotton culture into Australia, and points to the conclusion that coolie management and labor are only to be resorted to when better is not to be had. I should much prefer the introduction of emancipated negroes with their families from the cotton-growing States of America, and, as I apprehend one great consequence of the American crisis will be a disruption of the slavery tie in the southern States, free negro labor will become abundant, and, consequently, cheap enough for Australian importation; and it is to be remembered that that labor is already skilled in the cultivation of the article about which we are now so anxious.

As the cotton plant, though intertropical as to climate, is certainly indigenous in Asia, Africa, and America, and that, too, beyond strictly tropical bounds, and as Dr. Mueller, in his *Fragmenta Phytographiæ Australiæ*, published at Melbourne in 1859, thus describes a plant, "Malvaceæ Gossypium Australe," I assume it to be indigenous in Australia also; and as the cotton plant (on the authority of Royle) has been found flourishing in such far distant islands as the Galapagos, the Sandwich, the Seychelles, Java, Borneo, and other islands of the Indian Ocean, and also in the islands of the Chinese coast extending up to Japan, and as cotton has yielded to successful culture in Sicily, Naples, Malta, Spain, the Levant, Egypt, Morocco, China, Persia, and many other places, as well as in India and America, and has thriven in Turkey as high as the 45th parallel of latitude; and as, on the authority of Stuart, an American traveller from whom I shall quote, it has to some extent supplanted tobacco culture in the comparatively northern State of Virginia; and as the Sea Island variety, though considered by some to be a native of the arid climate of Persia, has attained its greatest present development in the comparatively ungenial climates of Georgia and Carolina, cotton cannot be so nice in its climate requirements as some authorities surmise: and I hold it to be the duty of the Executive of Victoria to demonstrate to England forthwith, by a series of trustworthy observations and experiments in well-selected districts, that several profitable varieties of cotton do not require more climate heat for their perfect development than favoured localities in northern Victoria and in Gipps Land, at all events, possess. Experiment in southern Victoria may await until the result of the first process shall have vouched the cotton-growing capabilities of the colony in the affirmative. As the 45th parallel of latitude is the highest point which I have seen instanced in cotton growth, I shall quote my authority, which is that of Dr. Jennings in his *Family Cyclopædia*, published in 1822: "Cotton although a native of the torrid zone, is yet produced in Turkey as far as 45 degrees north latitude." There is evidently a predisposition in England, grounded probably on erroneous impression as to climate requirement, to acclaim Queensland as pre-eminently the cotton colony of Australia; so that, if Victorians are supine and do not lucidly exhibit in fair rivalry the climate advantages of their splendid district north of the mountain ranges, they are not to be surprised if Madame Queensland laughingly appropriates to herself the Austral cottonian wreath, regardless of the rights of older sisters to coparceny in its wear. I have to add, that Royle has cited Astrakhan, in latitude 46°, in the Eastern hemisphere, as

his extreme latitude as to eastern culture, and has mentioned latitude 37° as his American extreme, being in both cases a degree beyond my instances; and I notice that Phillips, in my extract from him, intimates that a species of cotton plant has been found in America in latitude 40°, so that Mistress Tasmania need not despair of sharing with her juvenile sister an occasional right to the wear of the gossypium wreath.

The River Murray leaves the colony of Victoria (of which it is for 560 miles the northern boundary) near the 34th parallel of latitude, and between that river and the 37th parallel is situate the sixteen millions of acres of splendid cotton-climated land to which I have before adverted. A glance at the map of the colony of Victoria prefixed to this essay will show the position of the mountain ranges which so eligibly divide the colony precisely where convenience would desire. I have always considered the position of those ranges as the finest physical feature of the colony (apart from any appreciation resulting from their auriferous and other mineral treasures), and that the dual climate blessing which emanates from that position confers just title to the epithet Australia Felix, which was first bestowed on the colony as its name. It is obvious that no English garden was ever better protected by judiciously placed walls than the bulk of this highly favoured district is by the position of the ranges, and as the whole of the north Victorian watershed is northernly towards the Murray, it is apparent that, if it were possible to move the colony round, as on a pivot, to obtain a sunny aspect, that which a benignant Providence has kindly bestowed could not be improved upon. The district in question has, moreover, the rare Australian advantage of being well watered by the numerous rivers and rivulets shown on the map, which originate in the ranges and flow into the Murray.

As I do not see how Queensland can have cheaper labor than Victoria might have, and as there can be no doubt as to the soil capability of Victoria in its southern as well as in its northern division, the question as to the capability of Victoria to compete with Queensland in cotton culture appears to me to be simply, what are the climate requirements of the various profitable varieties of cotton, and to what extent does Victoria possess land able to meet those requirements ? I have seen a statement that cotton may be grown to advantage where the mean summer heat averages 74°, and the mean winter heat is not less than 46°, if the climate affords at least eight calendar months between the frosts of spring and those of autumn. With these requirements I apprehend more than half the colony of Victoria could comply, seeing that the report on its climate, included in that on its resources, to which I have elsewhere adverted, states that in Melbourne the mean temperature of the air was for the years 1858 and 1859, 57·8°, and that the mean temperature of the surface soil of Melbourne for a year had amounted to 60·58°; it being to be observed that the mean of the summer and winter heat (74° and 46°) stated to be those required for the advantageous growth of cotton, is 60°. I have also seen a Melbourne statement, that, up to a given period in 1860, 365 consecutive days had yielded a mean temperature in Melbourne of 72·5° for the summer portion, and 45·3° for the winter; which, if correct, is not disparaging, but on the contrary trends to the assurance that in localities further north than Melbourne, and especially in those

which have the advantage of protection by the mountain ranges, combined with a northern aspect, and the Murray watershed, many of the more delicate varieties will succeed. We have, moreover, the statement of Humboldt, that the gossypium herbaceum is successfully cultivated in the temperate zone, where, with a mean summer heat of 73° to 75°, that of winter is not less than 46° or 48°; so that the success of cotton culture to some extent in Victoria may be safely predicted. It is matter of notoriety that in the great North American cotton district, the temperature of many winters gives an average much below 46°, and I have seen statements which reduce the average duration of the cotton growing season, over a moiety of the great North American district, to seven months certain, and, in some other places, to eight; whereas the average of the bulk of the colony of Victoria can, I apprehend, be sustained at nine, and, in the district below the 37th parallel of latitude, and in favored parts of Gipps Land, at ten months.

It may tend to success, if, in the introduction of cotton into Victoria, preference is given to seed grown in the northern states of Virginia, Carolina, and Georgia, because the plants produced from such seed are likely to be hardier and less sensitive as to temperature than plants grown from seed of warmer regions; and I think it probable that sixty years of Virginian and Georgian culture has constitutionally so modified the Sea Island variety there grown as to have adapted even it for some Victorian habitats, notwithstanding the supposition that failure might be feared as the result of an attempt to introduce that variety into Southern Victoria direct from the much warmer regions of either Persia or the West Indies, to one of which its origin must be assigned. It is only of late years that the climature department of agriculture has had philosophical consideration.

A cotton plantation at the gathering season, when the globes of snowy wool are seen among the glossy dark green leaves, is said by travellers to be singularly beautiful; and in the hotter countries, where the yellow blossoms and the ripened fruit are seen at the same time, the beauty of the plantation is considered to be greatly enhanced.

American cultivators of cotton have hitherto confined their attention to three varieties, which, though in fact perennials, are, owing to the abundance of slave labor, somewhat prodigally cultivated, as if they were mere annuals. These varieties are the Nankin, the wool of which is yellow; Upland Georgian, the wool of which is white, but which variety is also called "green seed," from the color of its seed; and the Sea Island, the wool of which is a yellowish white, and the seed black, which has caused the variety to be occasionally called the black seed kind.

Apart from the importance of cotton as a textile product, it is to be borne in mind that cotton seed contains a large quantity of almost colorless oil along with a brown resinous substance which colors the oil when expressed. The seed has been employed in cotton growing countries to make pectoral emulsions, because of the oil which it contains, combined with mucilaginous and saccharine principles; all of which, being nutritious and non-repugnant in taste, are universally employed in India and China in the feeding of cattle. The oil is also used as a lamp oil.

British attention having been called to the oil of cotton seed, an apparatus

was constructed to free the seeds from the short down or fuzz in which they were enveloped, before subjecting them to pressure in the oil press. The oil is described as being of a brownish color, with a slight tinge of green, and has been compared to oil expressed from partially scorched linseed, and it has been suggested that it might be useful in wool dressing. Dr. Anderson, the chemist to the Highland Agricultural Society of Scotland, is reported by Dr. Royle to have had sent to him the refuse cake obtained after the expression of the oil, which he thus described: "The cake had a brown color, and contained large fragments of the husk of the seed. It was very brittle, and broke much more readily than linseed cake; moistened with water, it appeared to be much less mucilaginous than that substance. Its taste was not unpleasant." In its analysis, Anderson pursued the method usually employed for linseed cake, determining simply those constituents upon which its feeding value was believed to depend, viz.:—

Water	11·19
Oil	9·08
Sugar	10·70
Albuminous compounds (nitrogen, 3·95) ...	24·69
Ash *	5·64

"By comparing these results with those of linseed cake, Anderson (observed Royle) found that this substance possessed very considerable feeding properties. The quantity of oil contained in linseed cake varies from 9 to 11, and is sometimes even as high as 12 per cent.; the quantity of nitrogen is about 4·5 per cent. These being the most important constituents of oil cake, and those by which its value is to be mainly determined, shewed that though the analysis fixed the value of cotton cake below that of linseed cake, it was nevertheless sufficiently high to make it a substance of very great importance to agriculturists."

I consider this valuable seed property of the plant as greatly enhancing the importance of cotton culture in Australia, because of the additional supply of cattle food and oil which will result from that culture, when it shall have been introduced into Australian husbandry.

Akin to cotton as a product is the down of a tree of magnificent growth called Bombax Ceiba, which is said to attain the height of 100 feet, and which, having a fine spreading top, is familiarly called the umbrella tree. Though not of the gossypium family, it appears to me to call for notice in Australian husbandry, because it produces a silky cotton like down, very soft and white, which has been found useful for stuffing pillows and beds, and supplying the purposes of feathers and down, though found to be too short and brittle for spinning purposes. It grows on the coast of Guinea, where it is held in veneration by the negroes, and it has been found also in the West Indies, and in South America and elsewhere. Vegetable introductions may be made at such a comparatively light cost, that I shall

* The ash contained—1·32 silica; 2·19 phosphates; 0·15 excess of phosphoric acid.

consider Australian husbandmen supine if such a shade tree as this for Australian pastures is not permitted to compete among the sylvans of Australian husbandry.

The seed of the herbaceous and barbadense varieties is, when cultivated as an annual in northern latitudes, planted in March, April, and May, and the crop is gathered in August, September, and October. In America, it is common to plant in rows four feet asunder, and sixteen inches between plant and plant in the row, on the Jethro Tull or drill system ; but in India the cultivation has hitherto been very slovenly conducted on the broad cast principle, and without the least regard to crop rotation ; and as the plantation is neglected at every stage of its growth, and there is also negligence even in the gathering of the crop, and in the process of detaching the seed from the down, the consequence is that Indian cotton is never worth half the price at which American cotton of the same kind sells.

It being important in cotton-growing to obtain as great a length of staple as is compatible with strength in texture in some cases, and silkiness in others, recourse must be had, in Australian husbandry, to the Sea Island variety (which is pre-eminent among cottons for its length of staple), in the endeavor to produce hybrids between it and the more promising varieties of the gossypium Australe of Mueller, and the hardier varieties of the gossypium acuminatum, herbaceum, and arboreum, and of such other species and varieties as shall be found, on trial, to thrive best in Australia : and I would, in the way of encouragement, remind Victorians how effectively Nature co-operated with Science in hybridising, in the instance of alsyke, in the clover family, its two choicest products of white and red.

The following documents and extracts throw light upon early cotton culture, when it was, as it were, in the sapling stage of its growth, and are therefore interesting to those who have it in charge to expand the *gossypium Australe* into the most gigantic species of its genus, speaking metaphorically, and in a commercial point of view.

" A very interesting set of experiments (says Dr. Royle) in crossing one cotton with another, was made by Dr. Thompson, at Sydney, and in the neighborhood of Moreton Bay; and some cotton has been grown at Bolwarra, near West Maitland. The plants were, when young, attacked by a grub, but many recovered from this, grew steadily, and became from 3½ feet to 5 feet high, branching, bushy plants, bearing on an average about thirty pods each; and it was remarked that the hot winds of the season when the experiment was made did not seem to injure the plants. But cotton plants (continues Royle) are able to bear a good deal of heat when they have not been previously exposed to much moisture ; and as the experiment was made in rich alluvial land, they were, no doubt, able to draw sufficient nutriment from the soil. There can be no doubt that cotton plants may exist through a long range both of temperature and of atmospherical moisture and dryness."

As the following quotations from Dr. Royle's "Illustrations of the Botany of the Himalaya Mountains," published in 1839, uphold to some extent my

supposition, that the Colony of Victoria may fairly indulge in the idea of competing with Queensland in the production of good commercial cotton, I shall here introduce them: "In a cultivated state, cotton is now distributed over a very wide expanse of the globe, on both sides of the Equator; on the north extending as far as the southern shores of Europe, and on the south to the Cape of Good Hope; in the islands of the Pacific Ocean, it is found, both in the Friendly and the Society Islands; nearly under the Line, it is cultivated in the islands of Celebes, Java, Timor, and the Seychelles, as well as in Kutung, where the best is said to be grown; extending northwards up to the Malayan peninsula, along the coast of Tenesserim into the Burmese territory, and from this westward into Siam and China, where there is a peculiar species. Cotton is common in every part of India; a wild species was found in Ceylon, and another in Silhet, by Dr. Roxburgh. From India the cotton plant seems to have travelled by the way of the Persian Gulf, into Arabia as well as into Persia, and from thence to Syria and Asia Minor. From Arabia, it was probably introduced into Egypt *viâ* the ancient commerce of the Red Sea with India, whence it seems to have spread into the interior of Africa, and to both its western and its northern coasts. The islands and shores of the Mediterranean long supplied Europe with all the cotton it required. During the reign of Napoleon, he caused it to be introduced into Corsica, Italy, and the southern parts of France; and Mr. Kirkpatrick cultivated it near Malaga, in Spain." "*Cotton is cultivated as high as* 37° *of north latitude in America; beyond* 40° *in Europe; and even as far north as* 46° *near Astrakhan.*" "With regard to latitude, the cotton of Java, under the Line, is almost the worst in the market, while that from Guiana and Brazil, within a few degrees of the Line, is the second in quality; and that from Jamaica, in 20° north latitude, which is more costly in production, is 30 per cent. worse than that from Demerara, 14° more to the southward; while the cotton of Georgia and the Carolinas, nearly at the northern limit of its extension, is the best that is produced; and the cotton of Egypt, of which the cultivation, with returning civilization, has returned to the country by which it was first made known in Europe, is of excellent quality." "It would appear, therefore, that not only is temperature necessary to be considered, but also the due balance between the supply of moisture to the roots, and its escape by the perspiratory surfaces of the leaves, as well as all the varied processes of a judicious culture, in addition to the choice of the species or variety to be cultivated in any particular locality. In the choice of seed, it does not follow that that which is best suited to one climate is the kind most eligible for introduction into another, where the requisites of soil and climate may be neither identical nor analogous. Dr. Rohr and Mr. Bennett mention that even in the same field, some plants were ten times more productive than others, and that a variety which was sterile in one situation became fertile when removed to another, which did not appear more favorable; while a kind that in one bore but little cotton, became most productive in a neighboring farm. Much, therefore, may be done in improving the kinds which already exist, by ascertaining with precision the parts of the country where the best cotton is already produced, the peculiarities of soil, climate, and culture,

selecting the most prolific plants, and extending their cultivation, to the exclusion of less fertile and inferior kinds; exchanging the produce of one place with that of another, and in selecting and preserving the best kind of seed. Doing, in fact, what is everywhere done by all who are interested in the improved cultivation of grain, vegetables, fruits, or flowers; and though some varieties are difficult to propagate by seed, yet others may be continued sufficiently long to attain the permanency of species, instead of the liability to change of varieties."

"The commercial value of cotton" (says Dr. Royle in his Treatise on the culture and commerce of cotton, published in 1851) "depends as well on the length, strength, and fineness, as on the softness and equality of the fibre. But these essential qualities are modified by color and cleanliness; that is, freedom from knots and impurities, so that there may be less waste in spinning. Formerly color had great influence, but now the great distinction is into long stapled and short stapled. Sea Island, or long stapled cotton, is the most highly esteemed of the cottons; and is remarkable, as well for the length and fineness of its fibre, as for its silky softness. Amongst white cottons it is distinguished by a slight yellowish tinge. It sells from 1s. 6d. to 2s., and has sold as high as 7s. a pound. The quantity is limited, from the peculiarity of the physical circumstances required for its production. The fibres are equable, about an inch and a half in length. Uplands, or short stapled cotton, under which names are now usually included the produce of the interior of Georgia and Carolina, as well as of Alabama, Mississippi, Louisiana, and Tennessee. It used to be, and is sometimes still, called bowed, from the cotton of Georgia having formerly been cleaned with the Indian cotton bow. Though shorter in the staple, and unequal, this, which is white in color, is much esteemed, and forms the bulk of the cotton of commerce. The staple is from an inch, to an inch and a quarter in length. The best Egyptian cotton ranks next to the Sea Island in quality and length of staple, though it is not usually so well cleaned. It was only about the year 1821 that the Pasha began cotton cultivation, by importing seed from America, the Mediterranean, and Brazil. These different kinds may, therefore, be met with in cultivation there; though the Sea Island yields the best kind of Egyptian cotton, which is there called Maho. It has a staple of one and a quarter to one and two-thirds inches in length. Some excellent cotton has been sent from Port Natal, and some from the west coast of Africa; that from the Island of Bourbon used formerly to be much esteemed. The West Indies supplied England with the bulk of its cotton in the eighteenth century, but the cultivation was neglected when sugar became more profitable. West Indian cotton is long stapled, silky, and might be produced of a quality equal to Sea Island. Bourbon cotton is the same species as that which is cultivated in the West Indies. South American cotton was, in 1780, considered by Bryan Edwards as the finest grained and most perfectly cleaned of that which was then brought to the English market; especially that of the Dutch plantations of Berbice, Demerara, Surinam, and Cayenne. The Pernambuco was afterwards sent of so fine and superior a quality, as to be highly esteemed; and its price ranked next

to the Sea Island. The staple is long and fine, generally well cleaned, and glossy ; some with a yellowish tinge spins into a stout yarn, which is much esteemed by hosiers. East Indian cotton varies much, and is all short stapled ; but it is esteemed for its color, though it is generally sent in a dirty state to market. Much cotton is cultivated in the countries surrounding the Mediterranean Sea. It is generally the produce of Indian species of the plant, though American seeds have been introduced into other places than Egypt. The cottons cultivated in Asia Minor and Greece, are generally known as those of the Levant and Smyrna cottons. The Italian cottons are produced in Sicily, in Calabria, near Naples, and in Malta ; those of Calabria and of Castellamare are the best, and are probably the produce of an American species. A Nankin cotton is cultivated in Malta, and used there. Most of these cottons are employed for native manufactures, in the countries where they are grown, or are exported for the use of the manufactures of the continent. They seldom reach England, except when the price of cotton is very high."

"The foregoing account of the several varieties of cotton may be appropriately concluded with the following tabular statement of the kinds and prices of cotton, as named in commerce, from the places of export."

Species of Cotton.	Commercial kinds of Cotton.	Prices per lb. in 1849.		
		d.		*d.*
Gossypium Barbadense	Sea Island	9	to	24
	Egyptian	6	—	$9\frac{1}{4}$
	New Orleans	$5\frac{5}{8}$	—	8
	Mobile and Alabama	$5\frac{1}{2}$	—	$7\frac{1}{2}$
	Uplands	$5\frac{1}{2}$	—	$6\frac{3}{4}$
	Demarara and Berbice	$5\frac{1}{4}$	—	8
	West Indian	$5\frac{1}{2}$	—	$6\frac{3}{4}$
Gossypium Peruvianum or Acuminatum	Peruvian	6	—	$6\frac{3}{4}$
	Pernambuco	6	—	$6\frac{3}{4}$
	Aracali and Ceara ...	$6\frac{1}{4}$	—	7
	Maranham and Para	6	—	$6\frac{3}{4}$
	Bahia and Maceio ...	6	—	$6\frac{3}{4}$
	La Guazana	$5\frac{1}{2}$	—	6
	Carthagena	$4\frac{3}{8}$	—	$4\frac{3}{4}$
Gossypium Indicum or Herbaceum	Smyrna	5	—	$5\frac{1}{4}$
	Prime Surats	5	—	$5\frac{1}{4}$
	Common Surats ...	$3\frac{3}{4}$	—	5
	Madras	4	—	5
	Bengal	$2\frac{7}{8}$	—	$3\frac{1}{8}$

"The cotton plant," (says Baines in his History of the Cotton Manufacture in Great Britain, published in 1835,) "in all its varieties requires a dry and sandy soil. This is the universal testimony of travellers and naturalists. It flourishes on the rocky hills of Hindostan, Africa, and the West Indies, and will grow where the soil is too poor to produce any other valuable crop. A mixture of siliceous and argillaceous earth is the most desirable, with

a preponderance of the former. A marshy soil is unfit for the plant ; and so little congeniality has it for moisture, that a wet season is destructive to it. Of the several diseases to which cotton is subject, and which make the crop a precarious one, the most fatal is the blight produced by wetness at the roots. The plant flourishes most, and produces cotton of the best quality, on the sea coast. It was mentioned, as long since as the twelfth century, by an Arabo-Spanish writer, that in Spain the sea coast was found best suited to the cotton plant. The same fact is familiarly known to the cotton planters of India, China, Demerara, and Western Africa. And above all, the proximity to the sea is found to be indispensable to the growth of the best cotton, by the experience of the planters of South Carolina and Georgia, who raise the finest cotton known, namely, the Sea Island, on the sandy coasts and low islands of the sea, and who find the same cotton degenerate, in length of staple and in quality, when grown inland. To this rule there are, however, two exceptions. The Pernambuco cotton, which is second only to the Sea Island in value, though still much inferior, is said by Koster to be injured by proximity to the sea, and improved as the planters recede from it. In Egypt also, it is reported by St. John in his travels, that 'the cotton of the upper provinces several hundred miles from the sea, is superior to that of the Delta.'"

"The celebrated Sea Island cotton," (says Baines in another part of his history,) "is much longer in the fibre than any other description. It is also strong, and even of a silky texture, and has a yellowish tinge. Its seed is black ; whereas most of the other American cotton is produced from green seed. It is of the annual herbaceous kind, and though introduced from the Bahama Islands into Georgia, it is supposed that Persia is the native country of the Sea Island species. The soil, and situation of the low sandy islands, which lie along the coast from Charlestown to Savannah, were found extremely congenial to the plant ; and from them the cotton which it produces derives its name. The quantity raised is however limited, by the peculiar combination of circumstances requisite for its production ; and only a very small proportion of the cotton grown in the United States is of this kind ; nor is the quantity at all on the increase. In the year 1805, the export of the Sea Island cotton was 8,787,659 lbs., and in the year ending the 30th September, 1832, it was only 8,743,373 lbs. This cotton being, from the situation in which it is grown, much exposed to the inclemency of the weather, varies greatly in quality, the finer sorts bringing often three times the price of the damaged sorts.

The following sensible letter on the growth of cotton, by Dr. Mueller, was recently laid on the table of the Legislative Assembly of the Colony of Victoria, by the Hon. J. H. Brooke:—

"Melbourne Botanical and Zoological Gardens,
"18th April, 1861.

"SIR,—In compliance with your request, I have the honor of submitting to you some brief observations in reference to the contemplated culture of cotton for commercial purposes in Australia.

"From the well-established fact, that cotton is successfully produced in favorable localities, not only of the countries within the tropical and sub-tropical zone, but also northward as far as the border of the Mediterranean sea, in South Carolina, and Northern China, it may be inferred that through a great part of the Australian continent, and more particularly along its littoral tract, the cotton plant will find a climate most favorable to its development.

"Whether in the cooler temperature of Victoria the important commodity can be produced in such luxuriance as to render it available for factories, remains yet to be ascertained, judging from the fact that the mean annual temperature of the vicinity of Melbourne falls considerably short of that of most cotton-growing States, and relying on the somewhat isolated observations that a number of plants of the Sea Island cotton, grown in the Botanic Garden of Melbourne, failed to produce cotton, or ripened their seed-vessels only exceptionally or imperfectly. Since however, the northern part of our colony experiences a much warmer climate, although subject to great ranges of the temperature, and since the eastern part of Victoria, under the favor of an aerial and oceanic current from a wide tropical sea, enjoys a climate so mild that palms and several other types of tropical vegetation are observed to descend to a latitude nearly as far south as that of the city of Melbourne, we may feel justified in predicting a successful issue of any contemplated experiments to raise cotton in those more genial parts of this colony. And here I would draw special attention to the promising features which are held out for such enterprises by the basaltic plains along the Murray, and by the diluvial banks of the lower Snowy River, the Genoa, and other eastern streams of Victoria.

"In New South Wales the gossypium, has been proved to be very productive of fruit, at least as far south as Maitland; and even the mean temperature fixed for the cultivation of some varieties of the herbacious cotton plant is almost at a par with that of Port Phillip, for it appears that the intense heat of the summer, (for instance, in Louisiana, Mississippi, and Alabama), under the favor of dew and frequent showers, is sufficient to ripen the cotton fibre in regions otherwise subject to frost during the winter.

"No doubt, however, can be entertained as to the perfect suitability of both climate and soil of tropical and sub-tropical Australia for supplying cotton in vast quantity to the commercial world. Extensive trap-downs (occasionally at moderate distance from available shipping places), and the alluvial deposits in the vicinity of the coast, and along many rivers, as well of Eastern as of Northern Australia, are equally inviting to the cultivation of the cotton plant.

"Moreover, even from Arnheimsland towards Central Australia, many tracts may at a distant period become available for the above purpose, as is sufficiently demonstrated by the fact that I discovered there, the true rice in a spontaneous state of growth, rice being usually concomitant as a cultivated plant to that of cotton.

"The climate of North-Western Australia, however, would in all probability prove too oppressive during the summer months to Europeans for field

labor, and it would probably be needful, to give impulse to any design of establishing cotton plantations in Arnheimsland, whenever that part of Australia will be re-occupied, by rendering labor from other countries of the torrid zone available for the purpose.

"But whilst it is pleasing to anticipate that Australia (at least as a whole) will offer to future colonists almost unbounded fields for adding cotton as one of the most important articles to her exports and to her manufacturing resources, it remains as yet to be shown whether, at the present price of cotton, the labor in a country so extensively auriferous as ours can already be brought to bear on a competitive development of this important future source of employment, comfort, and wealth in this part of the world. Yet it must be borne in mind that some of the juvenile and aged portion of our laboring population would in the cotton field obtain that more easy manual work which neither the ingenuity of machinery can supersede, nor the task of furthering to the surface the mineral treasures of this country can readily and with equal certainty offer.

"It will, therefore, be a wise measure to give, as contemplated by Government, the utmost encouragement to the establishment of cotton fields wherever the soil and the climate appear promising, and to await meanwhile the results of experiments, which may possibly be more favorable for the practical solution of the labor question connected with the establishment of cotton plantations than has been hitherto anticipated.

"I have the honor to be, Sir,

"Your most obedient Servant,

"FERD. MUELLER,

"Government Botanist.

"To the Hon. J. H. Brooke,

"President of the Board of Land and Works."

I have to remark, in regard to the foregoing letter, that I do not construe it as being discouraging, inasmuch as the partial failure of the Sea Island plants in the Botanic Garden at Melbourne might have been feared, because, with the exception of the hirsutum family, the Sea Island variety is more particular in its climate and other requirements than any other gossypium. It will be seen by the foregoing extracts from Royle and Baines, which I have introduced purposely to vouch the pertinence of my remark, that, according to Royle, "the quantity [of Sea Island cotton produced] is limited, from the peculiarity of the physical circumstances required for its production;" and that according to Baines, "owing to the peculiar combination of circumstances required for its production, the quantity grown was very limited," even in its own peculiar Sea Island districts, so that the culture of Sea Island cotton had not increased during the twenty-seven years which had elapsed between 1805 and 1832. Probably the application of Mr. Seagrave's prescription of salt mud mixed with broken sea shells and sand, with some atmospherical protection, might induce Melbourne plants to ripen their seed and produce good cotton of even this variety. The experiment ought to be tried, at all events to an extent sufficient to mature a few plants for experimenting with.

Phillips, in his "History of Cultivated Vegetables," thus writes of cotton : "From Arabia it would naturally travel towards China, through all the countries which lie below the 40*th degree of north latitude; but as a species of the cotton plant has been found in the same latitude in America*, it confirms the opinion that most plants spring spontaneously within a given distance of the poles, and that their varieties originate from the nature of the soil, or accidental impregnation from plants of a similar species." And Phillips adds that "Nieuhoff, who was in China in 1655, states that cotton grew in great abundance in that country, and was then one of the principal articles of its trade, the seed having been introduced into that empire about five hundred years previously; and that Siam produced most beautiful cotton, of which hose and other articles were manufactured, exceeding even silk for lustre and beauty, *the seed of which silky cotton had been sown in the Antilles, where the plants flourished, and yielded this delicate floss in abundance.*" "Calico, or cotton cloth, is so called from Calicut, a city on the coast of Malabar, where the Portuguese first landed on their discovery of the India trade route."

"A considerable number of varieties of cotton (says the editor of a Cyclopædia published by the Society for the Diffusion of Useful Knowledge) is certainly cultivated, although little is correctly known about them. In some of them the cotton is long, in others it is short; this has its seed white, and that nankeen-colored. One may be cultivated advantageously where the mean winter temperature does not exceed 46° or 48°, and another may require the climate of the tropics. This is just what happens with all cultivated plants. Some vines will produce only sweet wine, others only hard, dry wine, and some are suited only for the table; some potatoes are destroyed by a temperature of 32°, while others will bear an average English winter. Only one kind of wheat produces the straw from which the fine Leghorn plaits for bonnets is prepared. But to multiply such instances is unnecessary. There can be no doubt that the quantity of cotton will depend upon climate, in part, and upon the specific properties of different varieties, also, in part."

"Brazilian cotton (says Chambers, in his Information for the People) was first imported in 1781. Pernambuco cotton is very valuable, generally fetching a price next to that of Sea Island. The value of cotton for manufacturing purposes is reckoned by the length, strength, and fineness of the staple or fibres. The 'long stapled' or more valuable cottons are Sea Island, Brazilian, West Indian, and Egyptian; the 'short stapled' or inferior qualities are the upland cotton of America, the Orleans, Mobile, and Surat cottons."

I shall take my example of European cotton culture from the husbandry of Sicily, a country which much resembles the colony of Victoria, both in its climate and its soil. The variety of cotton which is there cultivated is of the herbaceous species, which being sown in March, begins to flower in July; healthy plants are stated to rise from three to four feet in height.

The seed is sown in lines three feet distant from each other, in clusters of half-a-dozen in a place two feet apart in the lines, and the plants are afterwards thinned to the strongest in a place. The land is irrigated once or twice a week, by means of furrows between the rows. The flowering season is usually over by the middle of September, and then the ends of the shoots are pinched off, in order to determine the sap to the capsules, which are subsequently collected by the hand as they ripen. This tedious process generally lasts until the end of November. The cotton and the seeds are then separated by manual labor, the cotton being packed in bags for sale, and the seeds being either bruised for oil or eaten, being considered both wholsome and nutritious. The cropping rotation of the Vale of Lorento, near Vesuvius, which is somewhat celebrated for its cotton farming, runs thus:—1, maize; 2, wheat followed by beans, which ripen in March; 3, cotton; 4, wheat followed by clover; and 5, melons followed by French beans, thus yielding eight crops in five years. As water is commanded in the vale, it is distributed, as in Tuscany and Lombardy, to every kind of crop. The course of cropping might be bettered by extension, and the information would have been more satisfactory to me, had it been explicit as to whether the seed was consumed as human food or by cattle.

The following extracts, from the reports of the East India Company, throw light upon eastern cotton culture; and I give publicity to them now, along with the foregoing authorities, in order that, until Australian cultivators can have fuller details than I am at this time able to present, they may not be wholly without the experience of the past to guide them in the coming emergency. The series may be considered as well illustrating the progress of a very persistent though unsuccessful attempt by the Company to cope with the southern states of America in the production of cotton for the English market. My object in their selection from a scarce book of 431 pages being to describe the progress of Indian cotton culture, from its revival in 1788, in the language of the parties concerned in it, with the view of applying Indian experience to Australian benefit.

In a letter from the Court of Directors in England to the Governor-General in Council at Bengal, the Company thus write in 1788:—"We earnestly call your attention to the article of cotton, with a view to affording every encouragement to its growth and improvement in general, but particularly to the species manufactured into the finer sort of thread in use for the superior goods of the Dacca fabric, as we learn that many of our orders for those assortments have not been able to be executed for want of such fine thread.

"We have, in compliance with the wishes of the manufacturers, come to a resolution of importing 500,000 pounds weight of Broach and Surat cotton, or cotton of the produce of Bengal of a similar quality; you will, therefore, concert with our servants at Bombay the means of carrying this resolution into effect, and furnish us with every needful information respecting the article, as to its growth, quality, cost, the quantity which is capable of being procured for exportation, the political and commercial effects that

would arise from such exportation, and any other particulars you may deem it necessary we should be informed of."

The following account of the cotton used in the cloth manufactures at Surat is extracted from a letter written in 1790, by the Governor in Council at Bombay to the Governor-General in Council at Bengal:—"Cotton is produced from seed, and throughout this country the seed is nearly the same in quality. Only one kind of cotton is used in the cloth manufactures, but this varies considerably in value according to the part it comes from, the difference arising in a great measure from the soil, and also, in some degree, from the manner in which the cotton is extracted from the pod. This last reason particularly affects and lessens the value of the Bownaghur cotton, it being always more full of dirt and leaf than that of any other part, and the soil being poorer the becas grow much smaller.

"The seed, which is usually put into the ground as soon after the first fall of rain as the earth is sufficiently softened to be easily cultivated, is sown in straight lines and as regular as possible, so that the shrubs may shoot up single and about a foot asunder. The ground is kept well weeded, and (except a sufficient moisture to soften it, so that the young roots may easily strike downwards) free from the water, carefully allowing none to lodge on the surface, it being pernicious both to the seed and shrubs. Cotton is seldom sown after the end of August in and about the Guzerat, from the great uncertainty of having sufficient rain at the time when the shrub most requires it. When the shrub is well advanced and strong, it requires no other moisture than the dews, which fall very heavy in this part of the country as soon as the cold season sets in, which is about the beginning of November. In three or four days after the seed is sown the shrub makes its appearance, and in five or six bears two leaves.

"In November and December the bud appears, which flowers in four or five days. The flower after continuing about the same time falls, and the pod appears, which ripens in about twenty-five or thirty days, but requires both sun and heavy dews to bring it to perfection. When ripe it bursts open on three sides and discovers the cotton. Five or six days after the pod is open the cotton is ready to gather, but may remain upon the shrub for ten days without injury.

"It is customary here to gather the cotton ten days after the pod opens, and then allow ten days more for other pods to ripen, and so continue gathering as they come forward till the month of April, by the end of which the cotton is all off the ground. The cotton that is taken from the shrub the first and second time of gathering is the finest, and it afterwards gradually diminishes in quantity, as the vigor of the shrub becomes more and more exhausted. At the season for flowering and budding, the sun and dews are much required, cloudy and rainy weather destroying the crop.

"Cotton ought not to be sown two succeeding seasons in the same ground, though it does not injure the ground to sow grain of different kinds, such as do not, like rice, require much water in it; yet, letting the earth be fallow one season, having it well cleared of weeds and roots, and thoroughly opened so as to imbibe the rains, much improves it, and makes it yield a

good crop of the finest cotton the next year, provided the season is not unfavorable. Among the poorer planters it is customary to sow cotton every year in the same land, but it generally lessens the crop considerably, both in quality and quantity.

"The seed for planting must be thoroughly cleaned of the cotton, which is generally done in this country by rubbing it over a cott, close and well strung with coir, the cotton and bad seed remaining on the cott, and the good seed falling through.

"Seed for transportation to other countries should not be separated from the cotton, but covered with it, be put into dry sweet casks, and placed in a dry part of the ship or vessel conveying it, not in the hold, as the heat will be too great and the air foul, nor exposed to wet or damp air, but in an open, airy, thorough dry situation, and it will in that state preserve for two or three years. If separated from the cotton it decays in a short time; and moisture, of course, occasions a premature vegetation. The cotton is cleaned of seed by small wheels, and the seed, when extracted, is used for sowing and feeding cattle."

Remarks on the culture of cotton at the Island of Bourbon, in 1811, state that "the cultivation of this valuable plant in this colony is of recent date, and has only been followed since the years 1788 and 1789. Towards the year 1796 the plant began to degenerate, and a greater quantity of cotton was produced of a yellow than a white color. This was at first attributed to a want of rain, and afterwards to the impoverishment of the soil. But observations and experience has since shown, that the cotton, shortly after flowering, was pierced by an insect which deposited its eggs in it; for in the yellow cotton a blemish is constantly found, apparently caused by the animal, which alters the color of the wool, and occasions its appearance before the time required by the nature of the plant.

"Cotton thrives best in warm low grounds. too much rain is hurtful to it, not only because excess of vegetation prevents the tree from producing so great a number of pods, but also from the injury sustained by the wool from the wet. Strong grounds suit cotton pretty well, and it succeeds tolerably well also on sloping grounds. Flat, free, and too rich soils, particularly those which retain humidity, have been found little suited to this culture. The shrub flourishes luxuriantly, the leaves and pods become formed, the former are large and of a dark green, but the tree produces little fruit. These observations are often made at Bourbon where the nature of the soil is much varied.

"Sandy mixed grounds of vegetable earths are very proper for the culture of cotton: it thrives there admirably, supports droughts easily and lives to a great age, although harassed by the axe, storms, and bad weeds.

"It is a common saying at Bourbon, 'no esquine no cotton.' This assertion is well founded, for a few years since the esquine had given place to a very thick kind of dog-grass, of which the fibres multiplying to excess necessarily smother those of the cotton-trees.

"The branches of the dog-grass are covered with small brittle leaves, which the wind takes off, and which stick to the husks of the cotton. If

the husk fall it is soiled by these bits of grass, which increases the trouble of cleaning. The esquine, on the contrary, has a smooth elevated stem. Its leaves do not come off, and its flower is neither in a branch downy or bearded, inconveniences which are found in many herbs from which it is necessary to cleanse the cotton tree. Its roots are remarkable, inasmuch as they do not extend beyond an inch, so that they cannot in the least incommode those of the cotton tree. In fine, the esquine has the advantage of forming a carpet, which covers the soil and protects it from the heat of the sun, and receives the husks which fall without soiling them. We have also at Bourbon the custom of planting peas in the cotton-grounds, which offer the same advantages as the esquine, and moreover procure a useful pulse in domestic economy.'

"At Bourbon they cultivate two kinds of cotton; one with a black smooth seed, easy to detach from the wool, and for this reason most esteemed. It results from this property, that the milling and cleaning are quicker, for crushed seed forms the principal dirt of the milled cotton. The silk of the cotton with black and smooth seed is inferior to that with white seed. This last kind is softer and more delicate; the difference is perceivable to the touch: the other is more rough, and gives way less easily under the pressure of the hand. But the cotton with white seed is much more difficult to cleanse from it."

"When the cotton-plant has reached the height of an inch, and the seminal leaves have generally made their appearance, it is necessary to inspect the rows, to replace the seed in those holes where this may not have taken place. When the plants are three inches high, the number in each hole must be reduced to two; unless it be apprehended that either of the two may die, then three or four should be left. Whilst the plant is young great care must be taken to keep it clear of weeds, that it may not be impeded in its growth. If the cotton-tree has been planted in November or December, it bears in six or eight months; if in winter, it is more backward, and only produces in May or June. Until that time it requires nothing more than clearing from weeds. Its greatest produce is at eighteen months or two years. It is gathered between the months of June, August, and September. It has been known to produce a few pods in October and November, and some trees have sometimes after their great crop, given a small one in the month of May following; but at this period, as after September, it is a mere gleaning. When the cotton-tree is in its greatest vigor the weeds do not appear to affect it much."

"At Bourbon, about the month of April, the cotton-tree begins to shed its leaves. This fall precedes the blossoming; fifty days after which the gathering begins. The blossoming varies from a month to a month and a half; but, in general, the earlier it takes place the more abundant is the crop. The earth should not be hoed when the pod begins to open, lest the dust should soil the wool."

"The dry soil, and climate of Guzerat," (say the Governor and Council of Bombay, in a communication to the Court of Directors, in 1812,) "are very favorable to the cotton-plant, for it is found to grow in the most sterile

districts, though less luxuriously; and the great demand and consequent high prices given of late years, have contributed much to the more extensive cultivation of the commodity, particularly further to the northward.

"The cotton-seed at Surat, which is all of the *black kind*, is sown annually in drills, at the distance of about one foot between each plant, after the first rain (say in July), the ground having been previously well cleaned and all the roots of the former crop carefully grubbed out, after which it arrives at maturity without any further care. Ground which has been one year in fallow is always found to produce more abundantly.

"There are three gatherings of cotton in one season. The first commences from the middle to the end of February, and yields always the finest wool, being the pods taken from the tops of the shrubs; the second, fifteen days later, is inferior; and the third inferior to the second, and is pulled from the lower part of the bush."

"With regard to rearing cotton on Salsette, it will appear from a report from the collector on that island, that they entertain no doubt of their being much land on Salsette which, according to the description contained in the printed directions forwarded by your Honorable Court, is well suited for the cultivation of cotton, as all the soil in the hilly districts seems to be of that nature; that Bourbon plants of cotton are partially flourishing in hedge-rows and elevated spots where the earth is free, but notwithstanding this favorable circumstance, every attempt that has been made to cultivate this production on Salsette has failed. Dr. Scott, a proprietor of land in the island, had once many acres in cotton, but after a few years he gave up the cultivation; and they have been given to understand that it has since been tried by the late Ordasee Dady and Hormasjee Bomanjee, also proprietors of land there, who have both expended much money with no better success."

"These failures are attributed to the same cause as those which have rendered many of the agricultural speculations in India abortive. The Hindoo laborer will never yield any adequate return for his wages when employed in agricultural concerns, even with the utmost vigilance of the farmer. The severe labor of working the soil, and every other duty incident to this calling, require a very strong interest to induce that attention to it which is absolutely necessary. This is entirely wanting in the day-laborer; nor is there any circumstances in his connection with his employer which gives him motives either of sympathy or dependence, which might excite in him sufficient attention to the work he is engaged in."

"There are two species of the shrub-cotton," (writes Mr. Bernard Metcalfe, an agent of the Company, in 1815, who had resided several years in Georgia and New Orleans, and had been sent out to instruct the Hindoos in cotton-cleaning, market preparation, and management, as practised in the American States) viz.: "The black and the green seed, in each of which there are, probably, as many varieties as of the gooseberry or any other shrub. The black seed is only cultivated in the West Indies and the Brazils, because the labor required in separating the cotton or staple from the seed is neither so difficult nor so tedious as the green seed. The cottons grown in India are for the most part a variety of the green seed, of which

some are more easily cleaned than others. Those that may be regarded a staple commodity of the country are principally found in the Company's possessions, in the Guzerat and the Broach, in the Maratta dominions, and the Ceded Districts of the Nizam: they are likewise cultivated to a considerable extent in the province of Bundelcund and the Rohilla country, as well as in the Southern Districts of the Peninsula. In fact, the cotton-plant is indigenous in most countries within the tropics, and cultivated in much higher latitudes, neither requiring a very rich, nor impoverishing a lighter soil. It has this singular property, of producing the finest staple where the waters are brackish. The Georgia Sea Island, the Surinams, and Demeraras are all grown on the border of the sea, and the prime qualities only as far inland as the influence of the sea-air and tide-waters extend. I have often regretted not having the means or opportunity to ascertain how far the lands in that great delta of the Sunderbund, and particularly the provinces adjacent, which after the secession of their waters during the eastern monsoon are so strongly impregnated with salt, would not produce cottons of an equally fine texture with those above-mentioned, and which in England always bear so high a price. The presumption is, the attempt would be successful, provided the black seed was procured from Demerara or Georgia.

"The cottons grown in the Ceded Districts are a variety of the green seed, to which they adhere with great strength, and are in consequence difficult to clean. The capsule and seed are both small, and the fibres of the cotton have the appearance of having interlocked in their growth. In confirmation of this, the American saw-gin sent out by the Company to Madras, which was imported from Charlestown, and no doubt constructed there by a regular gin-maker, and competent to cleaning the bowed Georgias, would not when the attempt was made to clean with it the district cottons, discharge the seeds, but became immediately choked. In fact, it was observed, those I had built on the same principle succeeded much better. But it was not from the introduction of any new machinery, but rather the improvement of that already in use, more particularly by introducing greater precautionary means in the first stages of its manipulation, the gathering in from the field (or as the Americans call it the picking), that I grounded my hopes of any improvement of the district cottons: for their principal deterioration is less from the quantity of seed in them, than their being specked and fouled with broken leaf. Any improvement of the cottons at present cultivated, after the experiments that have been made, it is evident must be by resorting to these means; and even then will only be limited, for the cottons generally throughout India are of so short a staple, that with all the care that can be given them, they will never have a much higher character. A more effectual improvement would no doubt be to send them the seed of a new and different variety of the plant."

The following account of an early experimental planting of Bourbon cotton on the peninsula of India is interesting to young beginners in the same line:—

"The spot selected for the trial was chosen from its local convenience for

superintendence; the soil a sandy loam, the general character throughout these districts. It afforded the means of irrigation; but these were not availed of, as it appeared desirable to ascertain the product of the soil without such assistance, which would have added very materially to the expense of cultivation, independent of the difference of rent of the land, which, if possessing means of irrigation, averages ten rupees per begah; if not, four rupees per begah is a fair estimate. The seed was sown in rows, distant three feet from each other, preserving the same distance of plants in each row. The sowing commenced at the end of July, 1816, after the first heavy rains were over. Bejaree was sown by drill, in the usual manner, at the same time with the cotton. The sowing of Indian corn with the cotton is recommended at the Isles of France and Bourbon, as affording protection to the tender plants from the heat of the sun until the grain be ripe, by which time they have acquired sufficient vigor. In the present case the bejaree answered the purpose equally well; and as the plant yields no return the first season, the crops of bejaree ought to pay the expense of rent and cultivation.

"The after-rains of 1816 were very scanty, and the plants remained in an apparently sickly and dwindled state until the rains of 1817, when they put forth most luxuriantly; so much so, that it was found necessary to remove every alternate plant, which left a space of six feet between each: still they were subsequently too crowded. I think eight feet would be a good distance. The flowering commenced early in September, and the cotton began to ripen in November. The gathering of the first crop was finished by the middle of January: a second crop may be expected in the month of May, but I imagine a very scanty one. Opinions are divided on the Island of Bourbon, whether the plant should then be cut down or simply left to the operation of nature. The preference can only be decided by experience, and I would, of course, recommend that one-half of the plantation be pruned, leaving the other to its natural state.

"There are two kinds of cotton cultivated in Bourbon; one producing a black seed, which is very easily detached from the cotton; the other a *white, adhering* so firmly to the staple, that the latter is torn from it, leaving the ends of its fibres in the seed, which gives it the white appearance. No sample of the white seed has been hitherto received. The culture of cotton has been introduced in the Islands of Bourbon and Mauritius within the last thirty years. It would be desirable to know from whence the seed was originally imported: in all probability it came from some of the French West India Islands. It is not unreasonable infer, that the Pernambuco, Sea Island, and other superior descriptions of cotton, might be successfully cultivated in this province."

"The cotton at present cultivated" (writes Mr. Randall, of the Company's service, in a memoir upon cotton culture, in 1819), "in the territories under Madras is not, generally speaking, of the best kind: much of the old native cotton is poor in produce and bad in staple. The most saleable cotton-seed for India would be from New Orleans, Brazil, and Bourbon, being the most profitable kinds of cotton, white in color, long stapled, and pro-

ducing the most wool from the pods, also the easiest cleaned from seed and the least troublesome in cultivation. These seeds, however, require after planting the nourishment of water during the hot months, and should be watered twice every week. Even the Surat and Ahmood cotton-seeds, for a change, would be better than what at present are used, which seem exhausted or worn out. In agriculture, it is well known that a change of seed is very beneficial in increasing both quantity and quality. The musters of cotton and seed sent with this paper are the produce of Brazil, or what is called kidney cotton, and Bourbon. Bourbon seed may be planted between small ridges of soil in open field, if the fields can be watered by wells, tanks, springs, or nullahs branching from large streams. The Brazil or kidney cotton is a tree which grows from ten to twelve feet in height, and which produces an immense number of pods, having the finest wool enveloped about conglomerated seeds, each pod having from six to ten seeds so conglomerated. This kind of cotton will succeed and thrive well on the banks of tanks, nullahs near springs, wells, and small streams of water: it is a very valuable kind of cotton. When the seeds are to be planted they are of course to be separated, so that each pod will produce six or ten-fold only in plants."

"The pods of Brazil cotton are large; the cotton separates easily from the seeds; the wool is very close enveloped round the seeds, thereby preventing pieces of leaf and dirt obtaining an easy entry. The Brazil cotton-tree is hardy, and after being exhausted makes good fire-wood. It lasts about seven years from the time of planting, and, when well up, is not easily injured by weeds; but it requires watering certainly twice in a week during very hot weather; in the rainy season it requires little or no attendance: it should at times be pruned of dead wood. I conceive from 500 to 600 plants will rise well upon an acre, and when full grown will produce each tree not fewer than five or six hundred good pods. I have myself counted even a thousand pods upon a large tree; but in all calculations it is best to be moderate, as least likely to deceive; I have, therefore, calculated only five hundred plants upon an acre, each full grown plant to yield five hundred pods. Two hundred and thirty pods, in general, will make a pound weight; and when the wool is separated from the seed, the produce of fine clean cotton is from one-quarter to one-third of the weight of every pound gross, cotton and seed. The muster now sent containing pods of Brazil cotton was actually planted and reared by myself. When I weighed thirty-six pods of the Brazil produce, the gross weight was 887 grains. After separating the wool from the seed, the wool weighed 234 grains, the seed 653 grains, not a particle of leaf or dirt in it. Thirty-six pods of Bourbon weighed gross 294 grains. After separating the wool from the seed, the wool weighed 80 grains, the seed 214 grains. Thus, it seems, Brazil cotton produces about twenty-five or twenty-six per cent. wool; Bourbon twenty-seven per cent. Mr. Metcalfe found that old native cotton produced only twenty-two per cent. of wool; and he declared, justly, that it cleared or separated most tediously, and was quite a vexatious proceeding. But the most remarkable circumstance is, that old native produce is not more than 30lbs. of clean cotton an acre. So small a produce has always surprised me, and caused a

suspicion that my information was not correct; yet, after every enquiry, I have not been able to find a better result. The Brazil cotton is about, taking the lowest calculation, seed and wool 1085 lbs. an acre, or 271¼ lbs. clean cotton free from seed; perhaps Bourbon may produce something more or less, depending upon how the shrubs come up, and thrive. To suppose that the natives of India, of themselves, will undertake any new scheme, is contrary to long and wide-spread experience. They are the children of very inveterate customs and prejudices."

"As to reasoning with them about the benefits of any new system or scheme, except in a very few instances, it is a vain attempt and a mere waste of time. They will coolly listen to such conversations, and then they will start the most absurd objections, give innumerable excuses, talk about their old customs, express dislike to innovation, laugh at the idea of increasing what is called by Europeans their comforts, and at last go away determined not to try anything new."

Among memoranda, on the culture and trade in cotton, in the East Indies, made in 1828, are the following statements, "The cotton shrub is indigenous throughout the peninsula of India, from Ceylon in the south to the foot of the Himalaya mountains in the north, and various kinds have long been known to the native cultivators, viz annual, biennial, and cotton of several years' duration. Some kinds scarcely reach the height of one foot, others attain ten or twelve feet, and some a still greater height. The species which is most generally, indeed it may be said universally, in cultivation in India, is an annual shrub, a variety of the green-seed kind, yielding a white pod; but even of this variety there are many sub-varieties, of some of which the wool is more easily separated from the seeds than of others. There are, likewise, cotton-plants with brown, yellow, ash-colored, and iron-grey pods. Some of the species have black seeds, some green seeds, and there is cotton found with red seeds.

"The introduction into India of new and better species, and of improved modes of preparing cotton for the European markets, has at various times during the last thirty years engaged the attention of the Court of Directors and of the Indian Governments, and also of the private residents, and the following kinds of foreign cotton, and probably others, have become objects of experimental cultivation in various parts of India, viz., Sea Island cotton, Barbadoes cotton, Brazil cotton, Bourbon cotton (both of the green-seed kind and the black seed varieties), and cotton from China.

"It would be matter of gratification, if it could be said that success had attended these endeavors, but the native cultivators do not appear to have given any or at most very little attention to the subject."

"The delicate fabrics of Dacca were at all times manufactured entirely from the cotton of that district, which is the finest of all the cotton produced in India, and is probably the finest in the world; but the growth of this particular kind of Dacca cotton is limited to a space of about forty miles in length by less than three in breadth, along the banks of the Megna, about twenty miles north of the sea. An attempt was made in the years 1790 and 1791 to encourage the cultivation of this species of Dacca

cotton in the other parts of Bengal, and the collectors of the revenue, with the residents at the commercial factories, were directed to distribute the seeds amongst the native cultivators; but the endeavor failed of success."

"Besides the general defect of shortness of staple, Indian cotton is liable to objection on account of its not being sufficiently cleansed from the seeds, leaves, and other matters. To remedy which the Court of Directors obtained from America patterns of the most approved machines in use in Georgia and Carolina, for separating the wool of the cotton from its seeds; and they also, in the year 1813, engaged the services of Mr. Bernard Metcalfe, but this person, after residing in India some time, finding that his endeavours to induce the natives to use American machines were fruitless, gave up the employment and retired from India altogether."

"We are informed," say the Court of Directors, in a communication to the Governor-in-Council at Bombay, in 1829, "that at least three-fourths of the cotton which is manufactured in Britain is the produce of Georgia and New Orleans, in the United States of America, being known in mercantile language as Georgia upland cotton and New Orleans cotton, and is exclusively the wool of the species of cotton which produces a green seed; and we are further informed, which is exceedingly material in the present consideration, that the Bombay cottons, particularly those of the growth of the districts near Surat and Broach, are little or nothing inferior to the upland American descriptions above named, the item of cleanness alone excepted, and that such Indian cotton might readily be brought into competition with the upland American. We are aware that it has been stated in a letter in your commercial department, that the seed of the cotton which is cultivated near Surat is black; but as the cotton usually grown throughout India is almost universally of the green-seed species, and we find that the seeds which are very commonly intermixed with the cotton imported into London from Bombay, are also green, we think it probable that your information may not have been correct on this point. But whether the seed of the Surat cotton be green or black is of secondary importance, as the produce which it yields, when carefully prepared, is much esteemed in the British market."

"Experience has convinced us, that the improved cultivation of Indian cotton, so as to render it fit for the British market, will not be effected merely by the countenance and occasional encouragement of Government; we have therefore resolved, that an experimental plantation for cotton shall be established, at the expense of the State, within the territories under your authority. The manner of carrying this into operation we are disposed to commit entirely to your judgment and local knowledge. It appears, however, that it will be advisable, in the first instance, that a piece of ground, either in the possession of Government or to be hired for the purpose, should be selected in the most suitable place that can be found, (say to the extent of perhaps two hundred English acres,) and that a person, either native or European, of competent skill in this branch of agriculture, should be entrusted with its management at a moderate salary,

under the general superintendence of the collector of the district, or the magistrate, or the commercial resident, as you may appoint.

"The first object to be attempted should be careful cultivation of cotton raised from seed of the best of the indigenous plants of India, such as the Bhyratta kupas of Bengal, or the best kinds at present grown about Surat or Broach, which will give sufficient employment for the first season; and before a second season shall arrive we will endeavor to furnish you with a supply of green seed from Georgia and New Orleans, which you will afterwards cultivate exclusively, or in addition to the native kinds, as experience shall render advisable."

"We have before shown, that the cleaning of the cotton from its seeds and impurities is a point of nearly equal importance with that of improving its staple. Upon a former occasion we transmitted to India machines for cleaning cotton, of the best construction at that time in use in the United States of America, and we also engaged the services of a person who had long resided in Georgia and was skilled in the use of them, but the object failed of success. We understand that the excellent condition* in which American cotton is now brought to market, is owing to the almost exclusive use of a machine of more modern invention, called Witney's saw-gin, which is represented to be so simple in its construction and so easily worked, that the cleaning of the cotton, which was formerly performed by separate tradesmen, is confided to the management of slaves.

"Although it is our desire that your attention should be chiefly given to the improvement of the native cotton, which we have particularly specified, and to the introduction of the upland American cotton, we see it right to suggest to you the expediency of further attempting, on a small scale, in different parts of the territories under your government, the cultivation of all the finer sorts of foreign cottons in different situations as to soil, and particularly in districts bordering on the sea-coast.

"We shall endeavor to procure various kinds of cotton-seed and transmit them to you for this purpose."

"My attention," writes Mr. Henry St. John Tucker, a member of the Court of Directors, in a valuable paper on the supply of cotton from British India, communicated to a committee in 1829, "has lately been called to the important question of extending the importation of cotton-wool from British India, both with a view to the great national object of rendering Great Britain, as far as possible, independent of foreign supply, in the first instance, of a raw material, upon which her most valuable manufacture depends, and also with a view to add to the agricultural resources of India, and in so doing, to facilitate the means of remittance from our extensive possessions in the East, which incur annually a political and commercial

* "The American cotton is not only free from any admixture of seeds, but is also divested, in the most complete manner, of broken fragments of the pods and other extraneous matters, as well as of discolored and damaged heads. Indian cotton, on the contrary, is greatly mixed with both."

debt to the mother country. I shall therefore submit, in a summary way, the results which I have been enabled to obtain by consulting the public records, and by personal communications and correspondence with those individuals (Dr. Wallich, of the Botanic Garden, and others,) who appeared to me likely to possess the best information on the subject.

"1. There are two species of the cotton-plant producing the wool which is used in our manufactures; the *gossypium Barbadense* and the *gossypium herbaceum:* and there are persons who maintain that an essential difference exists, not merely in the botanical character of the two species, but in the strength and durability of the filament which these plants produce. It is well known that the *gossypium Barbadense* is grown generally in America and the West Indies, and may be designated the cotton of the West, while the species *herbaceum* is a native of Asia, and may be distinguished as the cotton of the East.

"2. There are several varieties of each species, produced probably by a difference in situation, soil, climate and culture; and although the two species, with their several varieties, have an original and natural site, there is reason to believe that they can be cultivated indifferently, in any tropical situation favorable to the production of the plant generally.

"3. The cotton of the West, as the raw material of our manufactures, has hitherto borne, and still bears, a much higher price in the markets of Europe than the cotton of the East; although it is contended, that the fabrics wove from the latter surpass, in the essential character of strength and durability, those which are manufactured from the cotton of America.

"4. Without insisting upon the superiority of the eastern cotton as a natural production, its inferiority as an article of commerce, and its consequent depression in price, may be accounted for by the following circumstances, which operate in a greater on less degree in deteriorating its quality and merchantable value.

"First. The best variety is not generally cultivated for exportation.

"Second The best situations are not always chosen for its cultivation.

"Third. The mode of culture is essentially defective, the natives of India being in the habit of growing different articles of produce upon the same land at the same time, with little regard to a rotation of crops; and owing to this injudicious husbandry, and to carelessness and mismanagement in other respects, the shrub, which under proper care is elsewhere rendered biennial, triennial, and even perennial, is in India found to be an annual only.*

"* By some authorities it is considered judicious husbandry, to root up the plants every second or third year, and to change the seed periodically. The natives of India, where the plant is an annual, rarely, I believe, take the precaution to procure seed from other quarters, although this is known to be beneficial, both in rural economy and in horticulture. Where the cotton plant is biennial or triennial, it is said to yield the best produce in the first year, and so far the Indian cultivation may be right in allowing the shrub to die off annually; but it still may be highly useful to change the seed and to practice a more useful husbandry.

"Fourth. The cotton is not properly cleaned and separated from the seed the machinery employed for this purpose being very insufficient, and greatly inferior to that now in use in America.*

"Fifth. In consequence of the defects in the machinery, the essential oil of the seed is liable to be expressed and suffused over the cotton, to the injury of its color and quality.

"Sixth. The cotton being produced generally at a great distance (in some instances not less than a thousand miles) from the place of export, and the state of the rivers at the season of gathering the crop not admitting of its being conveyed the whole distance by water, it is frequently warehoused for months at intermediate stations, and a whole season is often lost before it can be packed and screwed for exportation.

"Seventh. During its progress to the place of export in loose bags or bales, partly by land and partly by water, it is much exposed to the inclemency of the weather; the bales are often rendered wet or damp † by the heavy rains which prevail in tropical climates, and the cotton seldom arrives at its place of destination without some discoloration and partial damage, incidental to its conveyance in open carts and ill-secured boats, during a long land journey and tedious river navigation.

"Eighth. Although attempts are made to clean the cotton, and remove the seed and particles of the pod and leaf, before it is submitted to the screw, this is never done effectually, and the extreme compressure to which the cotton is then subjected by this powerful machine, with a part of its seed and impurities still adhering, must tend to injure the fibre.

"Ninth. The heat and moisture of the hold of a ship during a long voyage, in which great alternations of temperature are usually experienced, may also tend to injure the quality of the article.

"Lastly. It may be observed, that the practice heretofore common in some of our provinces, of receiving the cotton in payment of rent and revenue, was calculated to make the cultivators more solicitous to increase the *quantity* than to improve the *quality* of the article. Their necessities, moreover, may be supposed to have compelled them often to gather their crop *unseasonably*, for the purpose of making these payments in kind; and it is well known that cotton gathered in wet weather is liable to be materially deteriorated in quality and value. The practice of receiving payments in kind has been discontinued at Bombay; but effects are often felt long after the original cause has been removed.

"* It has been urged, that the saw-gin tears and injures the filament, and so perhaps it does; but although hand-picking is very essential to aid in cleaning the cotton, it cannot become a substitute for machinery. In India, where labor is so cheap, the process of cleaning the wool ought to be well executed; but the churker (or cylinders) used for separating the wool from the seed is a very rude machine, and leaves much to be done by the hand.

"† It has been alleged, that the natives sometimes 'damp' the cotton in order to increase its weight; but the defect may be referred, with greater probability, to other causes."

"5. Without assuming the superiority of the Eastern cotton as a natural production, the greater degree of strength and durability of the fabrics made from it may be referred, perhaps, to the following circumstances.

"First. The thread spun with care by the hand is probably more perfect.

"Second. The operations of the loom, when conducted carefully by the hand, are not so liable to injure the fibre as the process carried on by machinery.

"Third. The process of blanching the brown web is effected in India by steam and the solar ray, and the texture of the fabric is not liable to be injured by the use of muriatic acid or other chemical solvents.

"Fourth. The fabric, for the purpose of being rendered more even and beautiful, is not exposed to the very delicate operation of singeing off the ends of the thread and other excrescences.

"Fifth. The raw material is not economized in our Eastern manufactures in any way to diminish the firmness and strength of the texture.

"6. The *Bairati kupas*, the finest variety, perhaps, of the Eastern cotton, is produced only in small quantity in the districts north-west of Dacca, and is never exported, I believe, as an article of commerce. Its favorite site seems to be the high banks of the Ganges (or as it is called in a part of its course, the Pudnah), and its tributary streams; but as the country adjacent is liable to annual inundation, the tract of land applicable to its cultivation is not extensive.* This variety, which is also called by the natives *Désy* (of the country), would seem to be as the name imports, the indigenous cotton of Bengal, producing those unrivalled fabrics, which have been known and highly valued in Europe from the earliest period of authentic history.

"7. Other varieties (the *Boghà kupàs*, &c.,) are found in Bengal Proper, and are used in its domestic manufactures; but the cotton which is exported to Europe and China from Bombay and Calcutta, under the denomination of *Surat* and *Bengal*,† is produced chiefly in the tract of country lying between the rivers Jumna and Nerbudda, and extending westward to the Gulf of Cambay. Cotton is also grown in the southern

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"* Many years ago I resided in this part of the country, and was induced, from the great superiority of the *Bairati kupas*, to send the seed, with a model of the *churker*, to my native island (Bermuda), but the cultivation of cotton was not prosecuted in that island. The fibre of the *Bairati* is extremely fine, silky, and strong, but the staple is very short, and the wool adheres most tenaciously to the seed. I have in my possession a specimen of the thread, which has been above forty years in this country, and is apparently still perfect.

"† The cotton exported from Calcutta as *Bengal*, bears a great variety of names on the spot (*Jalson*, *Kineb*, *Banda*, *Cuchaura*, &c.) derived from the place of growth or the principal marts to which it is brought for sale; but although the quality is very different, owing to a difference in soil, culture, and management, the cotton is all, I believe, of that description which Dr. Hamilton Buchanan designates *hill cotton*. The cotton of Surat differs from it only in consequence of the difference in local circumstances.

parts of the Peninsula, and is exported from Madras under the denomination of *Tinnevelly;* but the quantity produced is not very considerable, and the strong durable fabrics manufactured in the Northern Circars are made from cotton obtained from the territory of Berar and the neighboring districts. I may add, that attempts have been made to cultivate cotton on the Malabar coast, although it is understood that they were not attended with such success as to lead to a belief that the situation is favorable for the growth of the article.*

"8. An experiment was made a few years ago, under the auspices of Lady Hastings, to introduce the cultivation of two varieties of the Western cotton (the Barbadoes and Brazil), at a place called Futteghur, in the vicinity of Calcutta ; but although the cotton produced was reported to be of good quality, the experiment was upon too small a scale, and bore too much the character of mere garden cultivation to furnish any decisive result. It may be observed at the same time, that the thread spun from this cotton was not considered by the Indian manufacturers to be by any means equal in quality to that obtained from their own native cotton, it being estimated by them at eight† and ten per cent. below the value of the latter. This would seem to favor the notion that there is an *essential difference in the fibre of the Eastern cotton;* nor can it be disputed that the Asiatic fabrics,‡ from whatever cause, are superior in strength and durability to the manufactures which are produced from the cotton of America.

"9. The *Bairati kupas,* although its fibre be fine and silky, and admirably calculated for the manufacture of the muslin or thinner fabrics, has the disadvantage of a short staple, while the wool adheres so closely to the seed that it is with difficulty separated ; and this variety is otherwise, perhaps, too costly a production to enter largely into our manufactures.

"10. Athough some of the finest cotton is produced in islands and situations within the influence of the sea, this circumstance does not appear to be essential to the perfection of the plant, since a large portion of the

"* Attempts have also been lately made to cultivate cotton in the province of Cuttack, but I understand that they have not succeeded. More recently the cultivation of the plant has been undertaken in the Island of Saugor, but sufficient time has not elapsed to enable me to ascertain the result. Dr. Wallich is sanguine in his anticipations of success; and, in fact, it is well known that the plant likes an alluvial soil and the neighborhood of the sea."

"† Brazil eight per cent. worse, Barbadoes ten per cent. Both plants have, under culture, been found to be triennial (*i.e.* they produce for three years) The shrub will last longer, but is not productive after the third year."

"‡ The nankeens of China are, perhaps, the stoutest cloths manufactured from cotton ; and yet we do not know the plant which produces the wool, nor are we agreed whether the color be natural or artificial. The wool of the *gossypium religiosum* has much the same color, but it is not supposed that the nankeens are made from this cotton.

article used in our manufactures is grown in districts very remote from the sea. Still it is of importance, that the cultivation of the article should be promoted as much as possible in situations which are near the coast, or which have an easy communication with our sea-ports, because any difficulty or delay attending its exportation not only occasions expense, but in many cases renders the cotton liable to deterioration in quality and value."

"The color of the seed is a distinguishing character in cotton; but nature is arbitrary, if not sometimes capricious, in her arrangements, and the black and the green seed are converted into each other by a change of place and circumstances. The Sea Island cotton, which bears so high a price in our markets, is from the black seed, but I am told that, if it be transplanted to the upland or back country, the black seed in the second year becomes green, and the length and quality of the staple undergo a great change. Upon the whole, however, the green-seed cotton appears to be that which enters largely into the great bulk of our manufactures, and to which our attention should be chiefly directed."

It is remarked, in a communication from Bombay, in 1834, that, "the white-seeded perennial cotton, the New Orleans, and the Egyptian, appear to be deserving of particular attention in future experimental cultivation.

"The American kinds which have been grown in India have the creamy color common to Indian cotton, but that is no disadvantage. The growth in the United States is white.

"The Egyptian specimens are full as brown as the merchantable cotton imported from Egypt; but that color is not a disadvantage, as the cotton bleaches well. The seed cultivated in Egypt with so much success of late years, is understood to have been from Pernambuco, in which country the produce is remarkably white."

I shall now illustrate the growth of that great American plant of the Southern States, which has so completely outgrown and overshadowed its Oriental rival as to have made it, by contrast, a comparatively insignificant affair. Little did the loyal fugitives of the Bahamas think, when in 1786 they sent a few friendly packages of their cotton seed, in the way of remembrance, to the Sea Island friends which they had left behind them, of the immense commercial crop which that seed was predestined to produce; and as I like much to connect effects with their causes, whenever I have data for so doing, I have great pleasure in introducing a short series of American authorities, which appear to me to have that purport, to Australian notice, premising that I think it singular, that though America had several indigenous species of the gossypium family of its own, and one of them, the gossypium acuminatum, which had yielded the kidney cotton variety of Brazil, which was, from its first being known in cotton culture, deemed pre-eminent in value, the States should have nursingly trained the three immigrant varieties, of the Sea Island, the upland Georgian, and the Nankin, into the pride-stem of cottonian greatness, to the utter disparagement of their own invaluable species, which appear to me to have well deserved greater experimental attention than was bestowed.

The following letter by Thomas Spalding, an early Georgian cotton cultivator, is interesting from the light which it throws upon the early days of cotton culture in America :—

"It is known to many that cotton was cultivated for domestic purposes, from Virginia to Georgia, long anterior to the revolutionary war. Mr. Jefferson speaks of it in his Notes on Virginia. Bartram speaks of it in his Travels as growing in Georgia, and I have understood that 22 acres were cultivated by a Colonel Dellegal, upon a small island near Savannah, before the revolution ; but this was the green seed, or short-staple cotton. Two species of the same family then existed in this country, the real green seed, and a low cotton resembling it in blossom, both being of a pale yellow, approaching to white ; one with seed covered with fuzz, the other with fuzz only on the end of the seed. To explore the first introduction of the short-staple cotton into this country would now, in all probability, be impossible ; but we may very well suppose it was by one of the southern proprietary governments, and possibly from Turkey, the trade of which country with England was then of much higher consideration than it has subsequently become ; nor would it have escaped those proprietors, many of whom were enlightened men, that the climate of Asia Minor, where cotton grew abundantly, was analagous to the climates of the provinces south of Virginia.

"Just about the commencement of the revolutionary war, Sir Richard Arkwright had invented the spinning-jenny, and cotton spinning became a matter of deep interest. In England, cotton rose much in price; its various qualities attracted notice, and the world was searched for finer kinds. The island of Bourbon was alone found to produce them, and yet the Bourbon cotton greatly resembled in its growth our green seed cotton, although it cannot be its parent plant, for all attempts at its naturalization in Georgia (which were many and repeated) have failed. It gave blossoms, but was cut off by the frost in the fruit, nor would it rattoon or grow from the root the next year, in which too it resembles the green seed cotton of our country. This is all I am able to say, and perhaps all that is necessary to be said of the short-staple cotton.

"The Sea Island cotton was introduced directly from the Bahama Islands into Georgia. The revolutionary war that closed in 1783, had been a war, not less of opinion and of feeling, than of interest, and had torn asunder many of the relations of life, whether of blood or of friendship. England offered to the unhappy settlers of this country who had followed her fortunes, home but in two of her provinces : To the provincials of the north she offered Nova Scotia ; to the provincials of the south, the Bahama Islands. Many of the former inhabitants of the Carolinas and Georgia passed over from Florida to the Bahamas, with their slaves. But what could they cultivate ? The rocky and arid soil of those islands could not grow sugar cane ; coffee would grow, but produced no fruit. There was one plant that would grow, and produced abundantly : it was cotton. The seed, as I have been often informed by respectable gentlemen from the Bahamas, was in the first instance procured from a small island in the West Indies, celebrated for its cotton, called Anguilla. It was, therefore, long after its introduction into this country, called Anguilla seed.

"Cotton, as I have already stated, had taken a new value by the introduction of the spinning machines into England. The quality of the Bahama cotton was then considered among the best grown; new life and hope were imparted to a colony and a people with whom even hope itself had been almost extinct. This first success, as is natural to the human mind, under whatever influence it may act, recalled the memory of the friends they had left behind them.

"The winter of 1786 brought several parcels of cotton seed from the Bahamas to Georgia; among them, in distinct remembrance upon my mind, was a parcel to Governor Jatnall, in Georgia, from a near relation of his, then surveyor general of the Bahamas; and another parcel at this same time was transmitted by Colonel Roger Kelsall (who was among the first, if not the very first, successful grower of cotton) to my father James Spalding, then resident on St. Simon's Island, Georgia, who had been connected in business with Colonel Kelsall before the revolution. I have heard that Governor Jatnall, then a young man, gave his seed to Nicholas Turnbull, lately deceased, who cultivated it from that period successfully. I know my father planted his cotton seed in the spring of 1787, upon the banks of a small rice field on St. Simon's Island. The land was rich and warm, the cotton grew large and blossomed, but did not ripen to fruit; it however rattooned, or grew from the roots the following year. The difficulty was now over; the cotton adapted itself to the climate, and every successive year from 1787 saw the long-staple cotton extending itself along the shores of Georgia, and into South Carolina, where an enlightened population, then engaged in the cultivation of indigo, readily adopted it. All the varieties of the long-staple, or at least the germ of those varieties, came from that seed; differences in soil developed them, and differences in local situation are developing them every day. The same cotton seed planted in one field will give quite a black and naked seed; while the same seed, planted in another field, different in soil and situation, will be prone to run into large cotton with long boles or pods, and with seeds tufted at the ends with fuzz. I should have great doubts if there is any real difference in these apparent varieties of the long-staple cotton; but if there is, all who observe must know, that plants, where they have once intermingled their varieties, will require attention for a long series of years to disentangle them.

"Subsequently to 1787, as the cultivation of cotton extended and became profitable, every variety of cotton that could be gleaned from the four quarters of the globe has been tried, but none of them save one has resulted in anything useful. James Hamilton, who formerly resided in Charleston, and who now resides in Philadelphia, was indefatigable in procuring seed, which he transmitted to his friend Mr. Cowper, of St. Simon's Island. Mr. Cowper planted some acres of Bourbon cotton; it grew and blossomed, but did not ripen its fruit, and perished in the winter. Mr. Hamilton sent a cotton from Siam; it grew large, was of a rich purple color both in foliage and blossom, but perished also without ripening its fruit.

"Nankin cotton was produced at an early period, by Secretary Crawfurd. It was abundant in produce, the seed fuzzy, and the wool of a dirty yellow color, which would not bring even the price of the other short-staple

cottons, but I knew it to produce three cwt. to the acre on Jekyl Island, in Georgia. The kidney seed cotton, which produces its seed clustered together like a kidney, with a long strong staple extending from one side of the seeds, and which I believe to be the Brazilian, or Pernambuco cotton, was tried, and was the only new species upon which there could have been any hesitancy ; but this too was given up, because not as valuable, and not as productive. I have given the names of gentlemen, because I had no other means of establishing facts.

"Your very obedient Servant.

"Thomas Spalding,

"Darien, Georgia."

The Hon. W. B. Seabrook, the corresponding secretary of the Agricultural Society of South Carolina, in a valuable report on the causes which contributed to the production of fine Sea Island cotton, published in 1827, says :—"The plantations of the gentlemen whose letters are under review are similarly situated, four of them being indented with creeks, and located on large rivers ; and all of them, in point of effect, exposed to the salutary action of the ocean's spray. In proportion to the distance from the seaboard and to the want of a free circulation of air from the south, is in general the downward graduated scale of coarseness in the cotton produced. These causes operate increasingly as you recede from the ocean, until a point is reached at which long cotton cannot be profitably cultivated."

"Salt appears to be one of the principal causes of making the cotton fine in quality and long in the staple. Hence, and from the sandy nature of the soil, the sea coast is so favorable to the growth of cotton ; and hence it is established, that salt mud is the best manure for a cotton plantation. The cotton of Mr. Barder and his favored associates, is indebted for its celebrity to the combined requisites of fineness, strength, and evenness of fibre. Upon what principles are these distinguished properties dependent? These planters use, not only extensively, but almost exclusively, salt mud. This manure is known to impart a healthful action to the cotton plant; to maturate rapidly its fruit, and to produce staple, at once strong and silky. Mr. William Seabrook, from a steadfast adherence to the application of salt mud, has literally converted a pine barren to as fruitful a soil as Edisto Island can boast. That silicious and argillaceous soils, in the order narrated, are the best adapted for cotton, every cultivator of this article is well aware. From experiments by Captain Bailey, a member of this society, it has been clearly demonstrated that salt added to a compost, in the ratio of one bushel of salt to every sixty bushels of compost, has been attended with the most decisive advantages in relation to the quantum and quality of cotton. For every description of soil in which sand predominates, he felt warranted in averring that salt clay mud was the manure which would effect the double purpose of a profitable harvest, with its desirable correlative—a fine quality. Salt clay mud acts rather negatively than positively. It does not add very materially to the product of cotton ; but from its conservative and maturative power the fruit, which the combined operation of soil and season may have disclosed, it is nearly certain of

retaining and ripening. In a propitious season stimulating manures will yield a larger crop than salt mud; but, for a series of years, the latter will more certainly repay the industry and skill of the planter. For the cultivation of the best cotton there are two other requisites besides a sandy soil, proximity to the sea, and salt clay mud as a manure :—First, very great care is necessary in the selection of the seed ; and second, there must be diligence in weeding, pruning, and in every part of the cultivation. The seed should be selected from the most perfect, early stalks, produced on the best land ; and it is indispensable frequently to change the soil and situation, in order to keep up the quality of the produce yielded by any particular kind of seed."

"Whitney's cotton gin" (says an authority quoted in papers relating to an American tariff), "has hardly been of less importance than Arkwright's machinery." And "American cotton is not only freed from any admixture of seeds, but it is also divested in the most complete manner of the pods and other extraneous matters, as well as of discolored and damaged heads. Indian cotton, on the contrary, is generally mixed with both."

"Cotton (writes Stuart, who travelled in America in 1830) is most extensively raised in the southern States, and has, *even in some of the counties of Virginia*, supplanted the culture of tobacco." "The black seed and green seed cotton are the two kinds generally cultivated. The black seed is of superior quality, and thrives best near the sea coast; that of the finest quality on the Sea Islands of Georgia and South Carolina. The green seed is more prolific, is not so liable to be damaged by the inclemency of the season, and is better adapted to inferior or exhausted land. Cotton is cultivated as an annual plant, growing sometimes as high as six feet, and throwing out a number of branches, on which form large and beautiful whitish-yellow blossoms. It is kept perfectly free of weeds, and is thinned carefully with ploughs in the form of scrapers. The process of picking commences in September, and is renewed again and again as it ripens, at successive periods. A laborer will cultivate, with ease, more than twice as much cotton as he can collect. The ordinary quantity picked in a day is between 50 and 60 lbs. Children from eight years old can be employed to advantage to pick the cotton. On the cups of the flower balls or co-coombs, or, as they are here called forms, grow three or four elliptical seeds, three or four times as large as a wheat kernel, and of an oily consistency. The cotton is the down with which these oily seeds are generally enveloped. The gathering season often continues for three months, or more, until it is necessary to burn the old stalks, in order to commence ploughing for a new crop. The quantity of oil that cotton seed yields has been estimated at about one gallon to one hundred pounds of seed. The cotton in the seed undergoes an operation called ginning, performed by a machine discovered by an American, which detaches the down from the seeds and blows it away, while the seeds fall down by their own weight. It is then packed in bales, which being pressed are ready for exportation. The quantity of cotton produced on an acre varies from 1400 to 800, or 600 pounds, 700 pounds being

a fair average crop. The price of cotton is extremely variable, the green seed fluctuating from sixteen pence sterling to five pence, and the black seed from one shilling to one dollar per pound. Much of the soil of South Carolina consists of swampy land, which is devoted to cotton and rice."

The following remarks on the culture of cotton in the United States of America were published in 1829: "The preparation of cotton-land requires most particular attention. It must be repeatedly ploughed and frequently harrowed, say twice or thrice, until it is thoroughly pulverized: drills four feet apart, in some instances three, are then made with a plough, into which, if the soil be poor, old well-rotted stable manure is placed, and at the distance of one and a half to two feet, a hole, not exceeding one inch to one and a-half inch in depth, is made with a hoe, and a handful of seed dropped therein, which must be immediately covered with the soil. The planting generally takes place between the 20th April and 10th May; the earlier the better, in order that the cotton may be matured before the appearance of the fall-frosts. The richer the soil, the larger and better the crop, as with every vegetable. When the plants are about one inch above ground, they are thinned with the hand, leaving four only. At a later period, and when all danger from worms, &c., is well over, they are again thinned, and two only are left to bear; from these, by hoeing or ploughing, the weeds must be kept clear, until the bolls are perfectly ripe and begin to open, which occurs during September and October. As they expand freely, the cotton must by hand be picked clean from the boll, and being a little damp, exposed for a day or two, in a dry situation, to the rays of the sun.

"The quality of cotton first picked is always the cleanest and best. To save trouble, it is customary with some planters to defer picking out any of the crop till the whole of the bolls be ripe, and have expanded and become dry by the influence of frost or cold weather. This plan is to be deprecated, for the bolls open most irregularly: those first expanded are left to be injured by rains, dews, and decayed leaves, &c. When the crop is picked from the boll, it is spread over the floor of a room (should the cotton be damp) till it is dry, and is then sent to the gin, when the seed is extracted from the fibre. During the first week in August some planters, when the crop is not too extensive, top each plant to the first eye, leaving six branches only to bear. This increases the quantity and quality, but forces the plant to throw out suckers, which are most difficult to keep under.

"Stiff clayey soils require more seed than light sandy ones. The plant being very delicate, requires the united efforts of several shoots to force its way through the surface, which often becomes packed and hard. Where seed is abundant, a large handful should always be sown in each hole; where it is scarce and the land light, a small quantity may suffice. Two hundred English acres would require from eight hundred to one thousand bushels of seed-cotton.

"An acre will produce from one thousand six hundred to two thousand pounds of seed-cotton, or four hundred to five hundred pounds of clean or ginned cotton; but this is a large yield. Generally, on average soils, from

one thousand two hundred to one thousand six hundred pounds of seed-cotton, or cotton in the seed. are produced to the acre. Our bales weigh from three hundred and fifty to four hundred pounds."

The following statement, on the best method of cultivating New Orleans cotton, was published in 1836 : " The cultivation of cotton is simple and easily understood, so that a few general directions will suffice to describe our manner of preparing a cotton-field, and the care and attention requisite to keep it free from weeds and grass.

" As to the most suitable soil for growing fine cotton, I would prefer that which is rich, light, and dry ; but it is generally thought, that *new* land does not produce as fine a quality of cotton, as that which has borne one or two crops of grain previously. The situation should be such that there is no danger of an overflow of water, which would seriously injure the plant. In preparing the ground we use the plough entirely, and lay off the rows from four to six feet ; and where the soil is as rich as the alluvium of the low grounds on the Mississippi, even eight feet is not too much. We open the ridges by running a narrow drill, by plough or otherwise, and sow the seed in it as we would grain, covering it lightly with a harrow.

" The plant on its first appearance, and for some weeks, is extremely delicate and easily injured by careless working. The rows, at first thickly covered with plants, must in about ten days be thinned out, so as to leave the stalks single, at the distance of eleven inches or a foot from each other : or as some of the plants may be lost or destroyed, we generally leave two or three together ; but in about two weeks more, at furthest, they must be reduced to one, as experience has proved that the plants will not flourish if at all crowded. While thinning the rows, great care must be taken to clear them of all grass and weeds : in the early age of the cotton this is done with the hoe. In a short time after, to facilitate the work, we use ploughs between the rows, where every thing must be kept down, and not a blade of grass should be suffered to grow. The only art in making a good crop of cotton is in the rule, not to suffer any thing to grow among the plants until it is fully matured.

" The time of planting, or rather sowing our cotton, varies according to the season Generally we begin from the 1st of April to the 15th ; as a rule, I would say as soon as there is no further danger of frost. These general observations, I trust, will be sufficient ; indeed it is impossible to fail in making a cotton crop, provided the ground be kept perfectly clean and the plants be not crowded. The quality of the cotton depends more, perhaps, upon care and attention in gathering and drying it, than upon the culture of the crop.

" From the 1st of September, or sooner, the bolls begin to mature and open successively, until winter has stopped the vegetation of the plant. As soon as the boll has completely opened, the cotton, which then hangs partly out of its shell, and has become almost dry, must be gathered by hand. Care must be taken by the picker to take hold, with his fingers, of all the different locks of the cotton, so that the whole comes out at once, and without breaking off any of the dry leaves about the boll. If any fall upon

the cotton before the gatherer (or picker, as we call the laborer) has secured his handful in the bag which hangs out at his side, it must be carefully taken off. It is necessary to use a close bag to gather the cotton: for the plant, though still flourishing, has on it many dead and dry leaves, which are easily shaken down; and it is this leaf which the spinners object to so much, and which will always lower the price and quality of cotton. After gathering the cotton, it should, as soon as possible, be exposed to the sun on scaffolds, and thoroughly dried; and if not immediately ginned and packed, must be stored in secure barns.

"I deem it useless to enter into a description of our gins and presses. I will only observe that a cylinder of sixty rags ought not to make more than six hundred to eight hundred pounds of clean cotton in twelve hours: if made to run faster, the cotton would not be so clean, and the fibres might often be broken or cut by the too rapid motion of the rags."

I shall close my cottonian extracts with the following short series, which have reference to other districts than India and the American States. It pleases me much to think, that the seed sown by the African Society has been long productive of good fruit; and as I think cotton culture will furnish to the free African abundance of that light kind of labor, in which his poor bonded brother has shown himself an adept, I shall heartily avail myself of the opportunity which resumption of cotton culture, in my field of mental labor will yield me, of supplementing the directions of the African Society by a contribution of my own, especially intended for African regions, in the way of return for any benefit which may accrue to Australian beginners from the African directions, until an Australian Cotton Grower's Manual shall appear in print.

"Previous to the year 1800," says Roger Hunt, in his Observations upon Brazils Cotton Wool, published in 1808, "Pernambuco cotton was estimated by the British manufacturer, chiefly for the fineness and silkiness of its staple; but at that time a large proportion of it was much reduced in value, by the quantity of stained cotton, as well as leaf, seed, and other kinds of dirt, which it contained.

"About the period above mentioned, inspectors appear to have been appointed in that part of the Brazils, for the purpose of remedying the complaints upon these points, and from that time all the cotton from Pernambuco has been greatly improved in cleanness and evenness of color; but by some mismanagement, the greater part of it has been gradually losing that soft, fine, silky texture, which formerly constituted its principal value, and a large portion of the import for some time past has been comparatively coarse in the staple and less bright in color.

"It may therefore be worth while, at our entrance upon the new relations which are likely to subsist between Great Britain and the Portuguese government established at the Brazils to enquire into the causes of this alteration in the quality of Pernambuco cotton, with a view to the recovery of its former valuable properties, and combining them with the improvement which has taken place in cleanness and evenness of color.

"The writer of these observations being unacquainted with the interior management of the cotton plantations in Pernambuco, is unable to say how far that part of the change alluded to, which relates to the fineness of the staple, may in any degree be owing to that invariable tendency which all vegetables have to degenerate, by inattention to the essential points of frequently varying and interchanging the seed and the soil: he will therefore deem it sufficient merely to have hinted at the necessity of these requisites being duly attended to, and confine himself to such causes of the change which has taken place in the general properties of this cotton as are more obvious, pointing out what appears to him to be the proper remedies, as he proceeds.

"The first and most material defect is, the state to which the cotton is reduced by the new mode of cleaning. Formerly (before this mode was adopted), it appeared to have undergone no operation but that of hand-picking, and was therefore, with the exception of being freed from the seed and some part of its other imperfections, sent to market in nearly the state it was gathered from the plant, which is the most favorable state cotton can be in for all manufacturing purposes, as the fibres will then separate with the application of a very small force, and thereby the process of carding (the first which it undergoes, and on the perfection of which all the rest depend) is rendered not only more easy, but much more perfect; whereas, by the new mode of cleaning, whatever it be, the fibres of the cotton are so entangled and matted together, as to produce a degree of stiffness and adhesion particularly unfavorable to the operation in question. It requires double the force in carding to separate the fibres, the effect of which is, to break the staple, and thereby to increase the proportion of waste usually made by the flyings from the cards; and after every degree of skill and attention on the part of the manufacturer, it is at last impossible to separate them so perfectly as to produce in the spinning a fine clear even thread. A further objection to cotton-wool in this state is, the additional stress which it lays upon the machinery, the effects of which are to reduce the quantity of work capable of being produced by a given power, and to increase the wear and tear, which in both cases adds to the expense of the article produced.

"Upon the subject of color, the want of that silky brightness which formerly characterized Pernambuco cotton, appears to arise from a part of the stained cotton being in the new mode of management so mixed up and incorporated with the good, as to prevent the possibility of its being afterwards detached, and thence a dinginess of color is communicated to the whole, besides the essential properties of the staple being injured in whatever proportion the stained cotton bears to the perfect. Thus it is that all the Pernambuco cotton, to which these objections apply, is reduced, in point of value to the manufacturer, to nearly the scale of the inferior sorts, such as Surinam, Demerara, &c., namely, two-pence, three-pence, and four-pence per pound, it being, for the reasons before mentioned, inapplicable to the finer branches of manufacture or to any purpose for which the above sorts are not nearly as well calculated.

"To obviate these defects, it is recommended that, in gathering the crop, particular care be taken to keep the stained and dirty cotton separate

from the more perfect ; which may be done, for the most part, by each laborer having two bags (or such other vessel as there may be in use), one for the stained and inferior, the other for the good cotton, in order by preventing their being mixed in the first instance, to avoid the necessity of any of those operations in cleaning, which produce that adhesion of the fibres, and that defect in the color so generally complained of. It is then recommended, that the prime part of the crop should, as far as the state of labor will admit, and after the seed has been carefully separated, be finally cleaned and prepared for the bag by hand-picking only, without the use of sticks to beat or shake out the dirt (called by the West India planters switching), or any other machinery whatever, it being in this stage that the mischief complained of (no doubt) takes place.

"A due attention to these particulars, would materially increase the value of the principal part of the crop, and would probably bring some of the finest marks into competition with Sea Island Georgia, which would produce a further advantage upon such marks of one penny to three-pence per pound ; and it is suggested that the stained and inferior cotton, after having undergone as much cleansing as circumstances will admit, would always find a market in England, at a price which would probably more than reimburse the planter for the extra labor bestowed upon the first quality. It is scarcely necessary to remark, that the practicability of what is here recommended must depend greatly upon especial care being taken, that in separating the seeds from the cotton they be not broken, and thereby mixed with the wool, which, whenever it happens, must necessarily render the process of hand-picking tedious and expensive.

"After what has been said relative to Pernambuco, it cannot be needful to advert so particularly to the other sorts of Brazil cotton : it will be sufficient to point out their faults, and refer to the management recommended above for the remedy.

"Maranham has, of late years, been for the most part coarse in the staple and dirty, and the dirt so incorporated with the wool as to be difficult and expensive to separate.

"Bahia cotton has retained its properties better than the two former sorts ; but its faults always were, and still are, a great deficiency in color, owing to the stained cotton not being taken out, and many bags having much whole seeds, leaf, and other kinds of dirt in them, which admit of an easy remedy by the mode suggested, of gathering the stained cotton separately from the good, in the first instance ; and as the pernicious method of cleaning adopted in Pernambuco does not appear to be in use at Bahia, this cotton would then come to market in the state approved by the British manufacturer.

"The writer being anxious to be fully understood, will here repeat that the great principle of what he wishes to recommend is, that after the cotton is gathered from the plant and the seed carefully separated, the prime part of the crop should undergo as little other change from the state it is in when gathered, as is consistent with its being bagged perfectly clean, as every process beyond that of hand-picking has an unavoidable tendency so to connect the fibres as to make them difficult of separation, and also to

deprive the cotton of that bright silky appearance, which formerly was the distinguishing character of the Brazil cotton-wool. He will also repeat the recommendation, that the stained and inferior part of the crop be rendered as clean as the state of labor will admit, and sent to market under a separate mark or title ; and will conclude by requesting the planter always to bear in mind, that the difference in price, in the British market between coarse and fine, clean and dirty cotton, falls wholly upon himself, the duty, freight, and all other charges (commission excepted), being upon the weight or package, and not *ad valorem*.

"The above remarks upon Pernambuco cotton apply with still greater force to nearly the whole of the import from Surinam, the mode of cleaning which (judging from the state of the cotton) must be still more objectionable than that used in Brazil, most of the Surinam of late years, possessing not only a more tenacious adherence of the fibres, but the staple being actually *broken*, apparently by some kind of machinery introduced to supersede the necessity of hand-picking (probably the gin used in America). This will account to the Surinam planter for that gradual approximation in price between Surinam and New Orleans cotton, which has been taking place for some years past, not from any improvement in the latter, but by the former being reduced in value, by the mode of cleaning, at least two-pence to three-pence per pound. It may be observed that *color* is not a subject of complaint in Surinam cotton, which for the most part is more perfect in that respect than any other sort.

"Nearly the whole of the Demerara and Berbice planters appear, of late years, wisely to have abandoned the injurious practice of *switching* their cotton, and it now only remains for them, by the method herewith recommended, to divest it of the stain and dirt, which is more or less a subject of just complaint against the greater part of what *now* comes from these colonies. Such marks as have come clean and even colored since the practice complained of has been discontinued, have generally sold higher than the best Surinam, and in some instances at the price of Pernambuco."

"Since the observations which I printed in 1808," adds Mr. Hunt in some further observations printed by him in 1828, "Brazil cottons have undergone some improvement. In consequence of the very extensive and growing application of the American Upland Georgia and New Orleans cotton to the purposes of the British manufacturers, added to the introduction of cotton from Egypt, since the year 1823 (which competes with the Brazil and other *black-seed* descriptions), there has been such an abundant supply of long-stapled cotton in proportion to the consumption, as to have reduced the prices of that class, at the present moment, to within twenty per cent. of the American green-seed cottons, taking the average price of each class ; whereas, previous to the import of Egyptian cotton, Brazils and other black-seed cotton generally ranged fifty per cent. above the American. If any further attempt should be made to improve the cultivation of cotton in India, the question occurs, how far it might be advisable to try the black seed, as an experiment, in the first instance, for the purpose of ascertaining the difference in the expense, compared with the quantity produced of each class.

"With regard to the leading descriptions of cotton at present produced in India (viz., Bengal and Surat, including in the latter the whole of the imports from Bombay), the Bengal may fairly be considered to be out of use with the British manufacturer. Surat cotton, such as a good portion of the imports of 1817 to 1826 consisted of (that is, good, clean, bright-colored, thomil cotton), would always find a consumption to a certain extent; which, of course, would be increased if the staple could be a little improved by the introduction of seed from America, particularly from New Orleans. The best quality of the Bombay cottons have always been considered to be the Broach and the Surat, which in good seasons are equal in staples to middling bowed Georgia. But the cargoes from Bombay, which have been arriving for the last twelve to eighteen months, have, from their almost entire want of every property estimated by the British manufacturer, been the cause of many of those who were previously in the habit of using Surat cotton turning their backs upon it; and it can only be by a very great improvement, particularly in cleanness, that they can be expected to return to it. It appears to me, that the cause of the depreciation is principally owing to the very slovenly way in which the crop is gathered from the plant; and without a thorough reform in that particular, it will be of little use introducing new seed, or increasing the expense of cultivation in other respects. If the crop be carefully gathered when in a proper state of maturity, agreeably to the instructions in my observations for the benefit of the Brazil planters, it will require comparatively little other cleaning, beyond freeing it from the seed by the American gin, in its most improved state."

The following directions for the culture of cotton in Africa, were printed by the African Society, after Mr. Hunt's publication of 1808; "Cotton grows in any soil that is not over moist. The common opinion, however, that it flourishes most in barren or impoverished land is erroneous. It will doubtless grow in thin arid soils not exhausted by previous cultivation, yet there cannot be a doubt that it will prove more productive in good or middling land, consisting of a loose dry mould free from clay or marl. If the inclination of the land be sufficient to carry off the water, the labor of trenching and draining which is necessary in level lands will be saved. As no plant requires so little rain as cotton, the close vicinity of high mountains is injurious to it, while it is beneficial to the coffee. On the other hand, the saline air of the sea-shore, which generally destroys coffee, is favorable to cotton.

"The land for cotton must be cleared in the dry season, and the operation should commence in sufficient time to allow the wood and brush which have been cut down to dry, so as to be burned before the rains set in. The process of cleaning need not be described. It would, however, be a great improvement of the method which prevails in Africa, if the underwood and small wood were grubbed out, and the large wood were not only cut down, but its branches lopped off, and its trunk also cut into such logs as may be easily removed and heaped together for burning. The more completely the ground is cleared, the more productive is the cotton likely

to be. It certainly, however, would not answer to grub out the larger stumps and roots; they must be left to rot, which they would do in a few years.

"In situations where the rains are not violent, the cotton seed is generally put into the ground at the early part of the rainy season. But in places differently circumstanced, this operation is deferred till the rains are within a month or two of their termination, with a view both to guard against an over-luxuriant vegetation, whereby the plants might exhaust their strength in branches and leaves, and to avoid the injurious consequences of rain at the time the blossoms are appearing and the pods forming. In Africa, the best time for planting the seed must be regulated by experience, and by the result of experiments to be made at all seasons, from March to September; but the earlier the seed can *safely* be sown the better.

"In Georgia and Carolina, considerable labor is bestowed in ploughing and harrowing the ground, and forming ridges raised pretty high with trenches between. This, no doubt, assists vegetation, and at the same time serves to carry off the water from the flat lands. The same thing is done, though less carefully, with hoes in Demerara and Berbice, but it is seldom done in the West India Islands There, however, the fields are regularly laid out and the holes opened in straight lines. The distance between the holes varies from five feet in poor soils, to eight feet in rich soils. The holes are made by loosening the earth for about eight or ten inches or a foot square, and five or six inches deep.

"From six to fifteen seeds, spread longitudinally, may be put into each hole, and covered over lightly with earth, not above one or two inches deep at most. The more moist the ground is the more lightly should the seed be covered, otherwise it will be apt to rot. The plants will generally show themselves in from five to nine days, but sometimes not before fourteen. When they have four distinct leaves, half the number in each hole may be drawn, and these must afterwards be gradually reduced until one, and that the most vigorous and healthy plant, is left in each hole.

"For the first six weeks the plants are of slow growth and very tender, and they must be carefully kept clear of weeds until they become of a sufficient size to suppress all extraneous growth. It would be of great service, also, that the earth should be occasionally drawn up about the roots until the blossoms appear, when this operation is no longer necessary. At the end of six weeks, if not before, the plants if luxuriant ought to be topped or pruned, by breaking or cutting off an inch or more from the end of each shoot, which makes the stems spread and throw out a greater number of branches; and this operation, if the plants are very luxuriant, will require to be performed a second or even a third time, with a knife, on the stem and branches.

"The blossoms generally appear in about eighty days after the seed has been planted, and sometimes later, and the first pods arrive at maturity in about three months from that time. The blossom of the green seed when it first appears, which is generally in the morning, is white, and remains of that color for the first twelve hours; but it changes the following night to a beautiful crimson, and drops off within thirty-six hours of its first

appearance. That of the black seed, or Sea Island, undergoes the same change with the green, but when it comes out it is of a deep yellow color.

"The cotton should be fully blown before it is picked. This may be ascertained by its separating *easily* from the pod or husk. When it adheres to the pod and must be forced from it, the cotton will be of an inferior quality. Great care should be taken to gather it as free from trash or dirt of any kind as possible, which will save much trouble afterwards in the cleaning. Cotton ought not to be picked after rain or while wet, as in that case it will be stained and of little value.

"In gathering the crop, particular care should be taken to keep the stained and dirty cotton separate from the more perfect, which may be done by each laborer having two bags, one for the stained or inferior, the other for the good cotton. The value of the latter would be greatly increased, and even the inferior would always find a market in England.

"The next operation is that of separating the cotton-wool from the seed. Of all the modes of effecting this, *hand-picking* is doubtless the best, because the most favorable state in which cotton can be for all manufacturing purposes, is, with the exception of being freed from the seed, that in which it is gathered from the plant. Whatever serves to entangle or mat the fibres is injurious, because when matted, they require in carding a greater force to separate them ; and the effect of this is to break the staple, and otherwise to produce waste and inconvenience to the manufacturer; besides which, a fine, clear, even thread, can hardly ever be produced from matted cotton.

"The process of separating the seed from the cotton-wool by the hand is in general attended with so much expense as to be impracticable ; though in Africa, perhaps, from the cheapness of labor, the difficulty may be less. Machines have therefore been substituted for this purpose, called gins, of which the common foot-gin is probably at present the best for Africa.

"There is another kind, calculated to work by cattle, wind, or water, which may hereafter be produced with advantage, but would be found too expensive and complicated at first.

"The black seed being loosely attached to the wool, is easily separated by the gin without injury to the staple.

"The green seed, on the contrary, adheres so closely to the wool that it can only be separated by a saw-gin, which cuts the staple and depreciates the cotton one half, but if *hand-picked* it would be more valuable.

"The green seed is more productive than the black, but the wool of the latter is of considerably higher value.

"It is hardly necessary to observe that that mode of ginning is to be preferred, which tends least to break the seeds and entangle the fibres of the cotton.

"After the cotton has been ginned, it should be carefully examined and freed from all motes, broken seeds, stained wool, &c., as its value in Europe much depends upon the condition in which it is packed The usual mode of packing is this. A bag is suspended through a round hole in the floor of the cotton house, its mouth having been previously distended by a hoop. Into this bag the cotton is thrown by small quantities, and pressed down by

a stout man standing in the bag with a pretty heavy pestle of hard wood. From two hundred weight and a half to two hundred weight and three-quarters, should be compressed into five yards of bagging.

"In America, four acres of cotton and four acres of provision are generally the proportion planted for each laborer, and which therefore each laborer is capable of managing. To pick fifty pounds of cotton in a day is considered as a fair task for one person.

"The plants should be cut down every year, within three or four inches of the ground. The time for doing this, which must be in the rainy season, ought to be regulated by the same circumstances which regulate the planting of the seed at first, and that the subsequent management, in this case, will also be the same as has already been pointed out in the case of the plants from the seed.

"It would be a great advantage, if every third, fourth, or fifth year at farthest, the plants were to be grubbed out, and their place supplied by means of fresh seed brought from a distance. This would prevent the cotton from degenerating, which it never fails to do when it has been propagated in the same ground for many years without a change of seed; and would, of course, preserve its quality and maintain its reputation in the European market. Great care should be taken to prevent a mixture of the different kinds of seed in planting: each kind should be kept perfectly distinct.

"The process called *switching*, or beating the dirt out of cotton by means of sticks, ought if possible never to be resorted to. The necessity of having recourse to this expedient, which can only arise from previous negligence, ought to be obviated by the means already pointed out; it deteriorates the quality, and consequently lowers the price of the cotton.

"In the gathering and hand-picking, and even ginning of cotton, great use may be made both of young children and infirm people, who are incapable of exertion of any other kind."

The following pertinent remarks on cotton appeared recently in the London *Times*, and were subsequently inserted in the Melbourne *Argus*:—"It is not that cotton will grow only on particular soils, like cinnamon or pepper, the article can undoubtedly be produced in fifty different regions of the globe, nor is there much reason to doubt that any quality desirable could be imparted to the crop, by cultivation and skill. This is not the secret of the matter. The real difficulty is that America has got fair possession of the market, and supplies us with cotton so excellent in quality, and so nearly sufficient in quantity that only narrow margin is left for fresh competitors. Coming to figures, we may state that the weekly consumption of the kingdom, in 1860, was probably about 48,000 bales; of these nearly 41,000 came from the United States, about 2000 from Brazil, 1800 from Egypt and the West Indies, and 3200 from India. There is the whole case clearly explained. America sends us six-sevenths of our entire supply, and maintains that vast supply so well and so successfully that the market is all her own." "All that we can gather from the American example is encouraging. That wonderful trade, which now yields the United States a

revenue of fully £40,000,000 a year, is as purely artificial as a trade can be. The plant was imported, and the labor was imported. Everything was accomplished by industry and enterprise ; and what has been done once can be done again. Take a soil and climate favorable to the growth of cotton, and the cotton trade can be created to a certainty. It was not even a work of time ; seven years sufficed to raise the produce of cotton in America from 500 lbs. to 18,000,000 lbs., from a single bale to 36,000 bales. It must be remembered, however, that this feat was only accomplished by untiring energy and abundant capital. The enterprise was amply remunerative, but no negligence was admitted in the work. The southern States fairly gave themselves up to cotton planting, and made cotton their sole staple, at the cost of all earlier products."

There does not, however, appear to me to be the slightest necessity for such an ultra course in Australian husbandry. All that I shall advise is to make cotton the chief Australian vegetable textile product, so long as its culture will pay equally well with any other product in the like demand, and similarly circumstanced in its requirements as to capital and labor, but not to an extent which might impede the due development of the other scions intended to be engrafted on the aspiring branch of our noble Anglo-Austral tree.

In bidding adieu for the present to the important subject of cotton, I may state that the foregoing remarks and their illustrative extracts are culled from a manuscript work on the subject, on which I have for some years employed my leisure hours, from a conviction that the importance of cotton culture would in my time induce Australian attention to it, and that a concise treatise on the subject was needed, that of Royle, which extends to 607 octavo pages, being too verbose for the majority of readers, and the history of Baines, which extends to 544 pages, being fuller on manufacturing details than of those on culture ; and I may add that what I now print, save to the extent of half a dozen pages, has found its way to the press thus early solely in consequence of my wish to aid promptly in the endeavor to improve the American crisis to Australian advantage, and to call attention to the promising indication that Victoria possesses cotton growing capabilities in great plenitude.

The scope and importance of the special culture branch of Austalian husbandry being now apparent, I shall close this department of my subject with the observation that though I have allotted in my agrarian domain, as adjusted for South Victorian management, so much, as a moiety of the whole, for the area of my lower branch, and have circumscribed the range of my middle branch within a lesser area, and of my aspiring branch within one still less ; I have, nevertheless, in cropping import, approached so near to a true tertial arrangement as that, when Australian experience shall have taught me what will most profitably fruit, my aspiring branch in a North Victorian domain I can, by assigning one of the cow pastures to the duties of the water meadow and adding the site of that meadow to the special

culture department, and curtailing in length the eight arable fields, and expanding correspondingly in width the four special culture allotments, readily, by mere reduction in the scale of dairying, which is essentially a South Victorian product, so enlarge special culture management as to obtain an absolute equilibrium in the tertial management of all my three branches, in the positions in which that equilibrium shall appear advantageous. When, however, it is considered that the eight arable fields are charged with the duty of providing the soiling and store food, and the grazing crops of cereals and clovers, for the middle branch, and of providing also land space for such of the textile and dye, and medical and commercial products of the special branch, as are adapted for annual rotatory culture, and are, moreover, jointly with the middle department, charged with the duty of providing manure for all the land in special crop, the approach to true tertial proportion is much nearer, even in a south agrarian domain, than may at first sight appear.

Having thus sketched in outline the three branches of our noble Anglo-Austral plant, I shall now discuss some important matters which my subject suggests.

Irrigation is predestined to be a prominent feature in Australian husbandry, and though it may seem paradoxical it is nevertheless my impression that irrigation will be more general, and will be earlier and better developed in Australia than it would have been had its rivers been without drawback and fluvial at all seasons of the year. The spur of necessity is an excellent goad for onward move; and I was much struck in a survey of the badly-watered districts of England, which I made before I left it, at the superiority of the contrivances for raising water to the surface, and for conserving it when there, to those of better watered districts. The pumps and cattle ponds evidenced that the men who constructed them understood their business, and they were generally very judiciously placed. The necessity for water conservation will lead to expert practice, as well as economy, in Australian water management; and I shall predict that miles of river-bed, when skilfully deepened where excavation happens to be soft, and consequently comparatively cheap, will be found to make excellent reservoirs; that the application of clay to porous places, to prevent percolation, and the construction of dams, to preserve elevation in rivers at present of little use, will lead to the irrigation of thousands of acres, which without water would have remained desert; that the hitherto incalculable waste of water, by exhalation from an unnecessarily expanded surface, will be

reduced amazingly by the confinement of that water within contracted, but deeper, surface bounds; and that the augmented capacity derivable by many existing lagoons, from judicious embankment, will justify the cost. A shallow lagoon is a nuisance, but deepened into an English mere it may become a blessing, and a source of wealth to its locality. Lagoons indicate the natural levels of a district, and many of them will doubtless be found worthy of conversion into public reservoirs. They ought all of them to be carefully examined in seasons of drought, with a view to prospective deepenings of the deep places, and by removal of the excavated stuff to the nearest shallows, make decided land of them, and thus lessen the surface exposed to evaporation. I have an impression that when the ratio at which evaporation progresses shall have been correctly ascertained, the extravagance of the Australian evaporative oblation to the clouds will be thought astounding.

Telford, the great self-taught engineer, in a communication to the Shropshire Agricultural Report, published in the year 1803, in which he expounded his views in regard to the improvement of the navigation of the river Severn, (an object then mooted), writes thus: "The second plan is to collect the flood-waters into reservoirs, the principal ones to be formed among the hills in Montgomeryshire, and the inferior ones in such convenient places as might be found in the dingles, &c., along the banks of the river. By this means the impetuosity of the floods might be greatly lessened, and a sufficient quantity of water preserved to regulate the navigation of the river in dry seasons, and to answer many other useful purposes, such as the forming of ponds for inland fisheries, the supplying artificial canals, and the watering of land. This, it is thought, might even prove the simplest and least expensive mode of regulating navigable rivers, especially such as are immediately on the borders of hilly countries." The idea was worthy of Telford. The Yan Yean reservoir of this colony may be considered as an illustration of Telford's thought.

I observed, with pleasure, a statement in the Report on the resources of Victoria, before adverted to, that in the Hamilton district "good water could be obtained wherever tried for, at an average depth of seventy feet." That circumstance indicates that there is, at all events there, a vast subterraneous collection of water, raisable to the surface by comparatively simple machinery,

and it strengthened a conclusion, to which I had arrived in England, that, though the exhalation of a warm climate having great surface exposure would account for the disappearance upwards of much water, it was, nevertheless, probable that more than was suspected, found its way, by percolation, to subterranean receptacles.

It happens luckily for the Victorian agriculturist, that water is essential for gold washing, and that its storage for that purpose has become an object of colonial concern. That circumstance has operated beneficially in procuring him a golden ally in his fellow colonist, the miner, who has had his application for aid responded to; and I think it probable that the gold fields water vote may initiate the adoption of Telford's fine conception as to a general system of water storage along the mountain range, which so conveniently bisects the colony. The diffusion of water, like the diffusion of knowledge, becomes enhanced in proportion to the elevation of its source; a lofty conception being worth a thousand grovelling ideas, and a gallon of water at the mean altitude of the range being of greater value for many purposes, than ten thousand gallons of the same water would be at the mean level of the surface of the colony. The books of the Sydenham Crystal Palace concern would, if referred to, as to their fountain-towers, and machinery cost prove this. The word "prospecting" having come into general Victorian usage, I would suggest prospecting water search reconnoitres along the ranges before private ownership shall have been allowed to create any impediments to the formation of mountain meres, exactly where they ought to be, in order to take a northern or a southern watershed, as the general weal of the colony may prescribe. It will be found easier and cheaper to reserve than to re-purchase, and I may state that my present object is rather to provide prospective facilities than to precipitate expenditure, knowing the delicacy and difficulty of dealing with vested rights, whether acquired by grant or by user. A granted eighty-acre section may be detrimentally in the way of irrigation over eighty thousand acres, and it is my wish to avert the intrusion of such "dog in the manger" policy into one of the finest fields for engineering enterprise which the colony has to offer, and which may affect, for weal or for waste, (by getting permanently into the wrong watershed, or making an improper detour), an incalculable quantity of the water of the ranges, which has called forth this suggestion.

I am anxious that every facility shall be given for the extraction of as much of the gold of the colony, as is findable, whilst its standard price is influenced by the erroneous notion that it is a scarce metal ; but I am impelled, by conviction, to state my belief, that the permanent wealth of the colony will be found in its agricultural resources, rather than in its mineral treasures. There will always be uncertainty and reckless gambling in gold mine management, the blanks being many, and the prizes few, though valuable when won, *if* kept from squander : but the agricultural produce of the colony will, if augmented by general irrigation, be both permanent and great, and the advantages are in prospect, such as will justify the agricultural interest, in claiming "prospecting" encouragement and water grant funds from the colonial revenue, to an equal extent with the mining interest. The agricultural returns, given in the Report on the resources of the colony, fully sustain my own estimate, that the produce of the land brought under efficient irrigation, may be trebled. The agricultural statistics of Italy give a greater increase, especially in the district of Lombardy, where the supply of water, on given terms, has long been a matter of public economy ; and as I see, by the Victorian Land Act, that rivers and water frontages are to be matters of government reservation, it will follow, that a trust for the due distribution of the water among the land owners entitled will attach upon the reservation. That trust will, probably, be delegated to Commissioners, or peradventure, to District Boards, or be placed under municipality jurisdiction : be that as it may, it will become one of the most certain sources of colonial revenue, if it is managed with skill and economy. In mining districts, the joint funds of the agricultural and the mining interests, will justify expenditure, which neither interest could risk separately, and it is in such districts that we are to expect the triumphs of engineering skill, in gaining or keeping surface elevation for motive power, or for feeding land which, by position, could not have been otherwise reached. If much of the mountain ranges shall be auriferous, or shall command auriferous land, or land yielding other valuable mineral products, the importance of every yard of permanent elevation in a mountain reservoir will be great ; and as the temperature of the air will, at an elevation, be cool, that circumstance will lessen waste by evaporation. Much will be effected towards a complete system of irrigation by attention to the following points,

viz., the establishment of a general system of lockage on such reaches of river bed as carry an approximate level long enough to justify the cost; claying over porous places, where the water is found to disappear, and piping water through sand-bed reaches to the next lower reaches which have retentive bottoms; the conversion of lagoons into meres of half their surface area, and ten times their storage capacity; providing artificial reservoirs in proper places, where none previously existed, and tracking surface indications of underground water runs, to the highest level at which, on the artesian principle, they can be brought to the surface as springs ; establishing connection, where thought desirable, between one body of water and another, so as to extend the benefits of irrigation as far as practicable; the drainage, into deep ravines, of shallow waters and morasses, so as to make the water available, and relieve the atmosphere from the noxious exhalations and insects which such localities engender; the ascertainment, in every locality, of the depth at which water is generally found under ground, and, as far as practicable, of the quantity of the supply, and to what extent it is effected by seasons of drought; and the ascertainment, also, of where the bulk of the water, which takes a downward course, first disappears, with a view to its prevention.

The irrigation of grass land, as practised in England, is of English origin and was not an Italian introduction. Nothing can be more inductively beautiful than the following incident recorded in the Treatise of Old Vaughan, the Father of English Meadow Floating published in the year 1610: "In the month of March I found a molehill raised on the brim of a brook in my meadow (in the county of Hereford), and from it there issued a little stream of water drawn by the working of the mole down a shelving bank, one pace broad and twenty long. The running of this little stream did wonderfully content me, seeing that it was pleasing green, and that other land on both sides was full of moss and hide-bound for want of water. This was the first cause of my undertaking the floating of ground, &c., &c., &c." Here we have the record of when and how one of the greatest of English agricultural improvements was suggested, and a text worthy of voluminous paraphrase in any system of Australian husbandry. I have often wished that the poet Cowper had been aware of this incident when he so beautifully apostrophized the mole in his

Task, because he would have contemplated with delight this little mole instructing Vaughan, and through him mankind, not only in the construction of a true artesian well, but also in the best application of the water which its engineering skill and labor had brought to the surface.

It has been ascertained that Victoria receives on an average as much rain water as England, and I cannot but think that if water conservation is economically and skilfully carried on, water meadows will be formed in many favorable positions at a reasonable cost, and that irrigation to some extent may be practised on every domain.

The *chemistry* of Nature is economy itself; no particle of any substance is lost in her operations. She literally extracts bread from stones, by making fertilizers of mineral earths, and deriving aliment for animal and vegetable life, as well from organic substances as from those which are inorganic. Nitrogen, carbon, oxygen, hydrogen, lime, magnesia, potash, soda, sulphuric acid, phosphoric acid, chlorine, and other fertilizing substances, at her bidding, pass out of any one of her three kingdoms into any other, and after having accomplished her purpose can be made to reassume the position in which she found them; measure for measure, weight for weight. What a fine field, therefore, is opened by the agricultural chemistry of the latter half of the nineteenth century to the industry and skill of the Victorian cultivator, who has within his reach nearly every substance, mineral, vegetable, and animal, which have been found to yield manure; and some of them cheaper and in greater abundance than the British farmer is able to procure them. The decomposed lava of some volcanic districts which, from its color, has been named chocolate soil, is a good fertilizer and will improve the staple of the poor lands of the localities in which it is found, if it is applied after the manner of marl, when the progress of settlement shall have given to poor land sufficient value to induce the operation. Beds of marl will probably be found, as in England, buried beneath many of the sandy districts, which only want their application on the surface to become useful land, and transmute them from the dreary sterility of desert wastes into districts as fertile as similar application has made that of English Norfolk.

The sources of *manures* appear to me so manifold, and some of them to trend so much in the direction of the marvellous and the vast, that I scarcely know what substance in the three kingdoms of nature to instance, from which fertilizing matter cannot be extracted; and, when I found in the English application of manures, so unpromising a material as granite, yielding when calcined a fertilizer of considerable value, a sort of mental ejaculation to the purport of that of friend Dominie Samson—prodigious! escaped me. Even sea sand, which in days of yore was metaphorically referred to as the emblem of the countless and the vast, must be content now-a-days to be reckoned in its aggregate as a simple unit in an agriculturalist's list of fertilizers, which are in reality inexhaustible; because, every grain of sand becomes a particle of fertility when mixed with clay, or some other such substance. Chemical science by revealing to the agriculturalist the constituents of manures of known efficacy, and by the discovery of new ones, has effected in my time a complete revolution, as well in theory as in practice, in their application: perhaps, I cannot better illustrate the obligation of agriculturalists to science, than by the following statement. In 1846, Professor Henslow, the botanist, laid a paper before the British Association, at Cambridge, on the abundant occurrence of the bones of whales, on the crag beds of the coast of Suffolk, along with large quantities of rolled pebbles, which were at first supposed to be coprolites, but which were in reality particles of phosphate of lime. These pebbles, though placed in a district where they were predestined to revolutionize the capabilities of the soil and though perceptible to view, had been unaccountably hidden from use, and might have long continued in that ignorantly hidden state, but for Henslow; who, in pursuing his inductive investigation and demonstrating the value of the deposit as a substitute for guano, performed a service to his country and to the agriculturists of other countries also, and probably to those of Australia, as well; for, as the southern hemisphere abounds in whales, it is more than probable that some of those which lived in ancient days have left their bones in similar deposit, as a fertilizing legacy to Australian husbandry, available when that husbandry shall have advanced in intelligence far enough to make discovery of the mortuary deposit, and claim the legacy.

The importance of manures and their mode of operation have, however only of late had due investigation; and though the day has not yet arrived in which an intelligent agriculturist can restore with precision to land coming forward in crop rotation the exact equivalent for the productive power expended in producing previous cropping, that day is probably not very distant; and I look forward to the feeding of plants by manure, skillfully cooked and applied, becoming as systematical and as well understood as has already become the feeding of animals with plants.

For my purpose a six-fold classification of manures will suffice, and I shall content myself with instancing just as many in each class as will illustrate the great bounty of nature, and warrant my conclusion that with thoughtful husbandry there will be no lack of fertilizing resources in Victoria; because it luckily happens that the bulk of them are procurable on reasonable terms; and it will, I apprehend, meet the requirement of

this essay, if I merely instance in regard to application the feeding of the crops enumerated in my own example course.

1. Animal substances yield :—Human excrement and urine; animal excrement and urine; poultry, and pigeon, and other land bird excrement; guano, which may be taken as the type of all sea fowl excrement; putrid fish; blubber, and oily substances; bones; horns; hair; feathers; blood; refuse fat and carrion; woolen rags; corals; sponges (which yield gelatine); lime; coprolites; and pebble phosphates, &c., &c., &c.

2. Vegetable substances yield :—the straw and chaff of grain; the haulm of pulse; malt dust; rape cake and refuse; cotton cake and refuse; linseed cake and refuse; hempseed cake and refuse; charcoal; woody fibre and ashes; tanner's spent bark; refuse hay; green crops to plough under; sea weeds and samphire, and their ashes; peat, and its products; vegetable ashes and alkalies; and the refuse of vegetable oils, &c, &c., &c.

3. Mineral substances yield :—Marl; chalk; gypsum; salt; alum; clay for burning, and also for mixing with other substances; sand and the debris of quarries; burnt granite; copperas; and bituminous matter, &c., &c., &c.

4. Mixed and Miscellaneous substances yield :—Soot; soaper's waste; gas works refuse; and a host, defying comprehension and compute, of artificial manures, which have given rise to a new commercial staple of great importance.

5. Composts of earthy matter; produced by intermixture with almost every one of the foregoing substances.

6. Liquid Manures: which, aided by irrigation, will in troth, become enriching streams of fertility. I may, in conclusion, state that the Flemings estimate the tanked urine of a cow at £2 per year.

The word conservation points explicitly to vast sources of manure as well in Victoria as elsewhere. Every bone, and every particle of animal and vegetable refuse, for which there is as yet no demand, ought to be collected and buried in proper localities until it is wanted. The same remark will apply to the sewage of our incipient municipalities, and though I do not wish to see the nasty practice of the nasty Chinese as to human excrement obtain in Australia, it ought not to be allowed to pollute rivers and watercourses, and be lost to agriculture by excessive dilution, when it can be easily conveyed by underground vaulting to some fitting and deeply sunk receptacle, there to abide until agricultural demand shall give it value. Urine is employed as manure, either in the liquid state or with the fæces which are impregnated with it. It is the urine contained in them which gives to the solid fæces the property of emitting ammonia, a property which they themselves possess only in a very slight

degree. "When it is considered," says Liebig, "that with every pint of urine a pound of wheat might be produced, the indifference with which the liquid excrement has been regarded is quite incomprehensible." The great chemist might have expressed himself still more strongly, had he chosen to do so, on the great waste in former times of all manures. The following quotation from Arthur Young's Agricultural Tour through the North of England, published in 1770, shows the comparatively recent period at which town manures became an object of sufficient value in general estimation to be worthy of conservation. In speaking of a locality in East Yorkshire, he says: "They are, throughout this track, attentive to the manuring of their land. Lime, after being long unknown, is coming into use, and those who have tried it find great advantage from the practice. Soap ashes they buy wherever they can, and find nothing to exceed them. All sorts of manure is bought at high prices at Hull, and carried nine or ten miles around. Rape dust from the oil mills is a capital article with them, having found it of prodigious benefit to all sorts of land; but it is chiefly laid on their barley land. All other sorts of manure, such as coal ashes, horse, hog, and cow dung, the sullage of streets, &c., &c., &c., is purchased at 3s. a wagon-load of fifty bushels, and spread on the fields to great profit. About fifty years ago, the manuring from Hull was begun by a poor man who hired a close of grass; he had four asses which he employed constantly in carrying away ashes and dung, and spreading them upon his pasture, the improvement of which was so manifest that his neighbors followed the example; whoever brought away manure, for many years, were paid for taking it. Twenty-five years ago it was to be had for less than a shilling a load, but the country around, by degrees, all coming into the practice, the price has arisen to its present height; extraordinary good stuff will sell for five shillings a load." How instructive and important was the lesson which the sagacious and industrious man alluded to by Young taught!

That manure, which is now allowed to be to land what daily food is to the animal, should have been so long in arriving at appreciation, and should have had such a discoverer, is a singular incident; and that it should be a century after that before liquid manure and its easier and cheaper distribution became appreciated, is as singular. The reliance of my course of cropping will be chiefly

on the homestead supply, and that supply will have its source in the soiling system, and in tank conservation. The judicious use of both solid and liquid manures is the point to be aimed at. It is not my intention to go through the various manures seriatim, as I should if I was writing a treatise, but merely to communicate some particulars within the range of my own observation and experience, as to particular manures in certain cases.

The classification of manures into those which amend the staple of the soil, and those which stimulate or improve vegetation is good, though some manures (as for instance lime) act as amenders of the soil, and as stimulators and feeders of vegetation also. The following remarks on the conservation and management of homestead manure, both in a solid and a fluid state, appear to me to fall within the proper scope of this essay, and I shall, therefore, adduce them; premising that some of them are only partially original, and that I shall adhere to the aphoristical form in which they stand in my note book.

In mixing the straw used as litter with cattle dung to increase its quantity, and afterwards by watering the mass to induce fermentation, the manual performance of Experience is in fact a scientific operation, and her inductive lesson accords with what Science thus taught: "Manure must be soluble before it can be effective; and this solubility can only be produced by the putrefactive process, which a moistened dunghill promotes." The exact stage of decomposition in which it is most advantageous to apply homestead dung has not, as yet, been conclusively determined by either experience or science, though much has been said and written by the disciples of both. Experience inclines to the opinion that it ought to be applied when the straw is uniformly of a mahogany color, and so rotten that it readily breaks into short pieces, without having entirely lost its form; and Science will probably endorse that opinion, though she has not, as yet, done so.

As manure is wanted at different seasons of the year, it is advisable to have it collected near the place of application; and so managed, as that so much as is wanted for a particular purpose shall be in a uniform stage of decomposition, as near the state thought most advantageous for the purpose in view, as is practicable; and, if the manure collected is not in that state when wanted, then the putrefaction of the oldest portion must be retarded, and that of the newest accelerated, until both old and new are brought to the same state; otherwise there may be mischievous contrariety of operation: when, however, the manure has been brought to a uniform state, as to decomposition, and has been ploughed in with a shallow furrow, it soon incorporates with the soil and affords a succession of soluble humus, or mucilage, which gives regular nourishment to the crop. It is sometimes advisable, for special or experimental purposes, to keep the dung produced from different animals, separate; as, for instance, the dung of cows distinct from that of horses, or of cattle feeding on oil cake or grain and turnips

from those fed on straw or refuse hay only. Cow dung has been found most effective on light soils ; and horse dung on those which are cold and heavy. The richer the food with which an animal is fed, the richer will be its dung, and the further it will go ; because, a less quantity will suffice to produce a required result. A general mixture of the dung of all the animals of an establishment, mixed with all the straw used in their littering, will produce manure of an average quality, adapted for any land and for any purpose, though, for light soils, it should be more decomposed than it need be for those which are heavy. *Manure being to land what daily food is to an animal*, ought to be supplied in quantity, and with a regularity proportioned to the exhaustion of the cropping taken ; but experience reports that with land, as with animals, it is better to feed lighty and often, than to gorge with a large quantity at once; save in the cases of such crops as potatoes, mangel-wurzel, and Swede turnips, which require a rich earth, and have been found to possess an amazing capacity for digesting manure.

It is acknowledged that urine and similar animal substances have a more powerful effect on the soil when they have undergone a certain degree of putrefaction than when they are used in a fresh state, and it is allowed that this putrefactive process is produced with the least loss of substance when the liquid has been confined in close vaulted cisterns which admit the external air only partially. On light soils this liquid has a most fertilizing effect, if it is used in small portions at a time. On very heavy soils this effect is not so apparent, and for such soils the liquid is mixed with sand or with any light earth before it is applied, or instead of using it at once upon the land it is poured over the litter which has been collected in a heap or in a yard after having served for the cattle. In the common mode of collecting farm yard dung, straw gets very unequally impregnated with animal matter; at one time it will contain a large portion and run rapidly into fermentation, at another there will be so little that it is with difficulty heat is excited in it. By separating the urine and the litter, straw will go much further, and can be mixed with the urine at the most advantageous time, and it thus forms a much richer manure in a smaller compass, from not being so much diluted with water. Should there be a deficiency of straw, earth or sand may supply its place, so far as regards the soaking up of the rich juices. The use of straw in dung may be considered as making it a sponge to hold the liquid animal matter in its pores or tubes. The great use of liquid manure on light soils is to impregnate them with soluble matter which, being diffused through their substance, supplies nourishment to the roots of plants wherever they may shoot out. It may be applied to the land at any time before the seed is sown, and also soon after the blade springs up or the seed begins to form; in short whenever the plant requires fresh nourishment, or when that which existed in the soil is diminished. Without liquid manure the poor sands of Flanders could not be cultivated, much less produce crops which vie in quantity and quality with those on the best soils. The quantity of dung, in a very rotten state, which this soil would require, according to the common system of manuring could not be produced by all the straw which could be raised upon it under ordinary cultivation ; but cattle produce urine, and urine produces

in return roots for cattle. The great effect of liquid manure has set agriculturists upon finding some artificial substitute for the urine and the watered dung of cattle; such substitutes are obtained by mixing all kinds of animal refuse with water and inducing putrefaction. The emptyings of privies is scarcely a substitute, for it is the same as the liquid from the stables in a more concentrated form, but the refuse of oil mills and various manufactures when diluted and mixed with a portion of putrid urine soon become assimilated to it. This has become a branch of trade in those countries where nothing will grow without manure, and is a resource where an increasing population demands the cultivation of inferior soils to supply the necessary increase of food, as well as an increase of produce from those which are naturally fertile. Notwithstanding the value and importance of liquid manure, it is not to be supposed that solid dung may be altogether superseded by liquid manure, which, however active and immediately effective, soon loses its power, whereas solid manure well prepared and ploughed into the ground will last for several crops. It is the judicious use of both manures conjointly which has the best and most permanent effect. Solid manure after being ploughed in requires time before it can have any direct effect on the germination of the seed, or on the nourishment of the plant; liquid manure, on the contrary, acts from the moment it is poured on the surface; it is the milk of the young plant, which sends out its fibres to receive it after it has undergone that slow transmutation which forms humus, and has become in a proper state to supply the more vigorous roots with sufficient nourishment. Various means have been adopted to increase the quantity and efficacy of manure. The simplest is to increase the number of cattle kept and husband their manure to the best advantage. It is evident that letting cattle roam at large in pastures is a great manure loss, not only on account of much of the dung which is dropped, but also of much of the urine which though the essence of manure gets thereby wastefully applied. On the contrary, wherever soiling and stall feeding are practised land gets highly manured, and the crops become more certain and abundant; for with stall feeding, as with the soiling system, is connected a much more economical management of homestead manure which is effected by keeping the litter and the more solid parts of the dung separate from the urine, and the liquid parts until collected in large reservoirs to be used either in the liquid state or applied immediately to the land, or in the formation of compost heaps with earth and vegetable substances purposely collected to be mixed with the straw which has served for litter.

Sir John Sinclair, on the authority of several eminent farmers, states in his Code of Agriculture that one ton of straw, if properly manufactured, will produce four tons of manure, and until Australian agriculturists shall have formed a reliable estimate of their own that statement may serve as a criterion by which to estimate any given year's manure from the quantity of straw used as litter. The exertions of an industrious cultivator to increase the quantity and improve the quality of every species of manure, both solid and liquid, will be repaid by the increased cropping which will be consequent, but careful experiment is alone to be depended upon in the adoption of new manures and of new modes of application.

Lime is both stimulative and enriching, and I am glad to find it abundant in the colony. I propose to use it on the clover leys for wheat, so that its application will recur on the same land every fourth year. That use will be consonant with good English practice on soils of strong staple, abounding in humus. It is useful both in its caustic state of quick lime, and in its milder form of carbonate, or chalk. Lime is less porous than sand, and more so than clay, and has therefore an improving effect on soils in which either sand or clay prevails. It acts also chemically as an alkaline earth, and greatly assists the good effect of the enriching manures of animal or vegetable origin. Newly-burnt lime has a peculiar effect upon all organic matter, which it burns or dissolves by taking from it a portion of the water and of the carbonic acid which it contains. On humus, which is the result of animal and vegetable decay in the earth, it has a peculiar effect, rendering it soluble in water, and, as a consequence, fit to enter the minute fibres of the roots of plants. This circumstance is probably the secret of the effect of lime on certain soils, and its comparative inaction on others. In some places where the soil is peculiarly poor—as, for instance, a pure silicious sand, washed by the sea or by rivers—lime is found to do no good, there being no ingredient on which it can operate; but on rich alluvial clays, which contain much organic matter, it is the best of manures, both in a caustic and a mild state. Caustic lime readily unites with the half-decomposed fibres of vegetable matter, such as straw, heath, and the like; and it accelerates their decomposition, inasmuch as by its means the dead fibres of the roots of vegetables which remain in the earth when the plant is removed, become soluble, and their elements entering into new combinations, supply the materials for the various vegetable substances which are then to be produced. As long as there is a store of organic matter or humus in the soil, lime will be found an excellent manure; but as soon as this is exhausted, lime only adds to the sterility by destroying the fibres which the seed throws out from its own substance by the assistance of light and moisture.

Lime therefore, when properly applied, is beneficial; but it becomes inert and even noxious when it is applied injudiciously. The property to which it owes its chief power in promoting vegetation, is its combining with certain elements of decayed animal and vegetable matter, and forming a compound which is soluble

in water, and attracts carbonic acid and moisture from the atmosphere. This substance is readily taken up into the sap by the fibres of the roots, and supplies the plant with oxygen, hydrogen, and carbon, which are the elements of all vegetable substances, except a few, which also contain nitrogen. Air, water, and carbonic acid are sufficient to afford all the elements of vegetables ; and the use of lime is chiefly to facilitate the absorption of these elements, in addition to depositing a very minute portion of the pure earth in certain parts of the vegetable. In addition to its effect on the humus of the soil, lime acts also on the clay which it may contain ; and where this is abundant, its effect is very beneficial. The use of quick lime in rendering inert vegetable fibres soluble, and hastening the decomposition of animal substances, is of the greatest importance in agriculture. Substances may be rendered highly enriching in a short time, which without it would have been long dormant in the soil, or on the dungheap. When there is peaty matter in the soil, which by reason of its tannin principle, is of itself incapable of putrefaction, lime is the true remedy ; for, assisted by fæculent matter to produce a degree of heat and fermentation in it, lime soon dissolves peat and converts it into real humus, than which there is no better food for vegetation. Lime has a leavening effect on strong soils, and renders them much more porous and receptive of the influences of the atmosphere than they were before its application. It also corrects acidity, and assists the nutritious effects of animal and vegetable manures. When spread over a soil abounding in vegetable matter, it makes it active by dissolving the half-decomposed fibres and converting them into a soluble mucilage ; and because of its property of attracting moisture rapidly, a small quantity produces an immediate effect ; and when spread over clover leys, preparing for wheat (which is its best application), it soon reduces the clover stems and roots to humus ; but the spreading is not to precede much the sowing of the seed, because it would, in that case, lose its chief power by attracting carbonic acid, and become carbonate, or chalk, and the expense of burning would be then in great measure thrown away. I have dwelt somewhat lengthily on lime because of the important part which it will have to take in Victorian husbandry, especially when railways shall have made it reachable in every agricultural district of the colony ; and the regular growth of clover and of some other

crops occasionally ploughed under, shall have periodically provided material which chemistry is to transmute into humus.

Chalk is composed of 44 parts of carbonic acid and 56 of lime. It is used to improve various soils. The best land for the growth of wheat contains a certain portion of argillaceous, siliceous, and calcareous earth, and when the last-mentioned is deficient, the addition of chalk improves the soil more than any quantity of animal or vegetable manure could do alone. The soils most improved by chalk are the strong wet clays which contain a portion of iron. Chalk acts as an absorbent, corrects astringency, and prevents, by its interposition between the particles of clay, that running into a solid mass which is so detrimental to the roots of plants, by entirely excluding atmospheric air. On loose sands its effects are different; there it acts chiefly as a cement, and the more argillaceous it is the better it binds the siliceous particles. An important use of chalk is to form ponds in porous soils for the use of cattle. A stratum of chalk, a few inches thick, protected by a coat of gravel and sand, to prevent its being trod through, will effectually retain water; and if a considerable proportion of salt is beat up with it, and intimately mixed, it will effectually prevent worms from making lodgments in it, and keep in water for a very long time. It is of advantage to throw chalk into all ponds used by cattle; as it corrects any acidity which may arise from stagnation, and the water in which chalk is diffused is more wholesome than that which contains clay alone.

Gypsum is found in several Victorian localities, though not as yet in large quantities. Its abundance in the neighborhood of Paris has occasioned its being called plaster of Paris. It is composed of sulphuric acid and lime; a ton to the acre, or a pint to four feet, is a fair application. The action of gypsum in producing luxurious vegetation is owing to its power of absorbing the ammonia of the atmosphere which by its solution in water and absorption in that state by the spongelets of the roots is thus yielded to the plants. The ammonia existing in rainwater is (whenever it comes in contact with gypsum) at once absorbed by it, and is no longer volatile, but becomes fixed. The decomposition of gypsum by this process of absorption of ammonia goes on very slowly, and this explains why the action of gypsum lasts

for many years. Gypsum has a septic quality which promotes putrefaction in animal and vegetable substances, and is therefore a useful ingredient in composts of which the principal part is farm-yard dung. The plants on which gypsum produces the greatest effects are clover, peas, beans, vetches, sainfoin, lucern, colza, rape, and plants with broad leaves. It has but little effect on the cereals. It is to be regarded as a stimulant, and not as a substitute for dung. The softer the water of the locality in which gypsum is to be used as manure the greater will be the effect. I propose applying it in my course with beans, peas, lentils, vetches, gramme, buckwheat, sorghum, hemp, clover, and rape.

As to *composts*, an economical practice which I first noticed in Cheshire, and subsequently introduced into other localities to advantage, is worthy of Australian notice. The fold-yard is excavated in the form of a washing-basin, and is in the beginning of winter bedded with a layer of loose soil a yard in thickness; by imbibing and retaining the ooze from the mixen above, this soil comes out in the spring first-rate stuff for top-dressing grass land, which is the purpose to which it is generally applied.

The fundamental principle upon which composts are made is that of impregnating portions of earth with those parts of the dung of cattle which, in common dunghill management, would have been dissipated and lost. Composts have the effect of accelerating or retarding the decomposition of animal and vegetable substances by the addition of earths, such as chalk, marl, clay, and even sand, according to the nature of the soil on which the compost is to be used.

In the formation of composts the principal objects are, to regulate the decomposition of the organic substances, and to increase the bulk of the manure, by means of less expensive materials than straw. For these purposes lime or chalk is generally preferred; the former, in its caustic state, to accelerate decomposition of fibrous matter, the latter to add to the mass and absorb any portion of acid, which is produced in a certain stage of the fermentation. The most useful material is peat or turf, which may be laid in layers with quick lime and earth, the whole being well soaked with liquid manure. If any kind of vegetable matter, such as fern, broom, the tops of heath, or pond weeds, can be added, it will be so much the richer. The lime and urine acting on the peaty matter, its tannin is decomposed and transformed into humus, the woody fibre is dissolved, and the whole mass, when turned over and well mixed, becomes a very rich earth; which, being spread on the land and slightly ploughed or harrowed in, greatly enriches its surface. By this means many poor soils may be improved when the cultivation is not sufficiently extended to produce straw.

Charcoal may be very beneficially applied to land whether in grass or tillage, especially where irrigation is not practicable. It has great powers of absorption both of moisture and the gases, and renders them to the land by gradual process. Pure and fresh-burnt charcoal has the power of absorbing 90 times its volume of ammoniacal gas, and 35 times its value of carbonic-acid gas; but the power is much diminished if the charcoal is reduced to a state of powder. When used for agricultural purposes it should be broken just small enough to allow of its being equally distributed over the surface of the soil. In this state it will absorb any gas with which it may come in contact, and if any manure has been applied containing ammonia in its free state, liable to pass off in a gaseous form, the charcoal will absorb it as it rises, and return it again to the plant with the first rain which falls. When, in the course of cultivation, the charcoal is ploughed under, it does not even then lose its powers of absorption, but continues its operations below the surface with considerable effect. Bakers' ember-refuse is worth collecting, and ought not to be wasted. Wood being abundant in the colony, charcoal may be had at a reasonable cost, and that circumstance will prove a great boon to the agriculturist. I propose to use it chiefly on the pastures and the permanent herbages of clover and lucern, and (if needs be, and the supply is equal to an allowance for the annual clovers) to extend it to them also. I am glad to find wood abundant in the colony, because, until irrigation comes into general operation, charcoal will be the great regulator of surface moisture by gradually yielding to the land and its herbage the moisture which it has absorbed. In pastoral districts, where irrigation is impracticable, charcoal will be found invaluable, and it is in dry climates like that of Australia that its beneficial effects will be manifest. This is one of the manures in which the Australian agriculturist has a great advantage, for the price of charcoal would be ruinously high in some countries.

Bone Manuring is one of the most important of modern agricultural improvements, and I have witnessed such surprising results from the application of ground bones in Cheshire and the adjoining counties of Salop and Stafford, that I shall enter my protest against the waste of a single bone. It is upon old grass land, on soils of a clayey texture, that boning has produced the amazing results

detailed in English agricultural publications. I was, myself, entrusted with a large boning outlay in a dairying township, the results of which greatly exceeded the expectations both of the tenants and myself, and was much quicker in its return than we any of us expected. The land had been previously underdrained with a view to the operation, which, no doubt, greatly facilitated the transition from very bad cow pasturage to very good. The two operations, in fact, doubled the rental value of the land boned. I had concluded my arrangements with the tenants at a midsummer rent-day, and fixed upon the fields to be first boned, leaving the purchase of the bones and their spreading on the land to the management of the principal tenant. He was very prompt, and was so fortunate as to get all the bones he wanted at one establishment, and, as the tenants co-operated well in their carriage of the bones, all the land was boned that autumn, which happened to be very suitable. The land having been all of it formerly under the plough, was in butts, and I directed a butt to be left here and there unboned, so that the effect of the boning might be apparent. At the Christmas rent-day, the boning affair was the chief topic of conversation, for all the tenants were pleased with the indications of improvement which had begun to be manifest, but as snow was on the ground, I had to be content with their report. The winter and the following spring were, both of them, very favorable; and when I visited the estate at the following midsummer rent-day, my path lay across an elevated field which, at the distance of a mile, overlooked the boned estate. The view delighted me, for my eye rested at once on every boned field. The yellow brown of the butts left unboned contrasted so disparagingly with the deep green of those which had been boned, as to be a conspicuous object of notice at the distance of a mile. On my arrival at the estate, I went immediately to a field, and cut two sods, one from an unboned butt, and one from an adjoining butt which had been boned. On dissecting the sods, I discovered that the change in the color of the herbage was to be attributed to the impetus given by the bones to the white clover pre-existing in the land, for round every splinter of bone a clover stem had entwined itself, and then, cherished by a new aliment, and strengthened by the support which connection with the bone afforded, it sent forth roots downwards into the decaying vegetable mass of coarser herbage, which had too long been paramount, and

had kept it under, and then threw out tendrils right and left, which, by contact with other splinters of bone, repeated the process until luxuriant clover had become the predominant herbage of land in which it had never been noticed before. The cows, unaccustomed to such dainty food, ate so greedily of it that they bared the ground, and that circumstance aided the effect of the boning, because the finer plants, which had also pre-existed in the land, encouraged by the improved texture which drainage had given to the soil, and enjoying for the first time free atmospherical exposure by the disappearance of the mosses and rough plants, in which they had been long stifled, and fed by the bone aliment and by that into which the corpus of their oppressing neighbors had been transmuted by the change, grew so vigorously that the change was really marvellous. On dissecting the unboned sod, I found that it contained all the plants which had had development by the boning, but so weak and silvery in stem, and scant in foliage, as to require care in their identity. The rental value of the land was doubled by the operation, and the change was permanent; for on visiting the district twenty years after the boning, I found clover still the predominant herbage, and was amused with the epithet "boned land," by which the land in question was then designated, by reason of its acquired value.

The bones had been boiled and subjected to a novel chemical process, to exact some ingredient wanted for some manufacturing purpose, which I understood was a failure. The circumstance had, however, created a local prejudice against the bones, which operated to our advantage, for we had them a bargain by taking the lot, though the success of our experiment, and the non-success of the speculation which had led to the boiling of the bones, prevented our getting our after supplies on easy terms as to price. We tried, on a small scale, crushed bones which had not been boiled at all, some also which had been half boiled, and some which had been fully boiled under the ordinary process, for all of which we paid comparatively high prices; but the cheap bones answered the best. The operation of the unboiled bones was slow, and it was a dozen years before remunerative effect was produced; but they in the sequel paid, and when I saw the land twenty years afterwards, the herbage was evidently much improving, and though white clover was not so predominant, some valuable plants of the locality, which I much liked, were gaining the perfect

development, which had given great value to the herbage of the land of the locality, which happened to be naturally good. The half boiled bones were comparatively high in price, and did not, either at the first or in the sequel, return benefit proportionate to their extra cost; nor did the boiled bones do so well as those which had been boiled for the specific object to which I have adverted, by which I inferred that some chemical agency, to which they had been subjected, had helped our purpose. Bones act stimulantly and powerfully on arable land, and I have seen great crops follow their application, especially on light soils in wet seasons; but the benefit is transient, and not of a permanent nature. I have an impression that the most economical Australian application of bones will be in renovating the natural pasturage of the colony, and developing indigenous herbage plants of value, which, from some obstructive cause, need nurture; and that is why I have given so much space in this essay to my English experience. Verily, every bone ought to be saved, and there ought to be at least one bone-mill in every agricultural municipality.

Though Australian *guano* is considered an inferior article in the English market, and is said not to pay for carriage there, it is sufficiently important to be conserved for Australian use. It is, as is well known, the excrement of sea fowl. The more ammonia it contains the greater is its value, and sixteen per cent. of that ingredient is expected in Peruvian guano. Some chemists, however, take the per centage of nitrogen as their criterion of value, and on that test report that a ton of Peruvian guano is equal to thirty-three and a half tons of mixed animal and vegetable farm-yard dung. The portability of guano is greatly in its favor, and it has been stated that it unites the advantages of active and of permanent manures in equal degree; half its fertilizing properties being soluble in water, and quickeners of vegetation, whilst the other half continue long in the soil and nourish vegetables by slow decomposition. I, however, question the permanency of guano effect, and am supported in my opinion by an incident which I will narrate. An English Squire, with whose estates I had an agency connection, being minded to create competition among his tenants in the production of Swede turnips, authorised a considerable outlay in guano, for the purpose. I procured first-class Peruvian guano, and the Squire, having a mind to try a little

experiment of his own upon a plot of grass land, caused thrice the quantity which I prescribed as sufficient to be spread on the plot. The weather was showery and favorable, and the grass and herbage which had had guano sprung up to a great height in an incredibly short space of time, and took such a beautiful dark green hue as to be quite a contrast with the surrounding herbage, but the following year it relapsed to its former state. Two years afterwards, on passing the plot, I had the curiosity to examine the herbage minutely, but no improvement whatever, either in the soil of the plot or in its herbage, had resulted. All the tenants had splendid Swedes, and the succeeding barley crops were in every case good, but we all of us concluded, that with the barley crop all advantage from the guano had ceased, and that the soil was not in any case improved in staple by the application. This was a fair experiment, for, though the soils were various, the result was uniform, and we all of us agreed that though the Swedes and the barley had well repaid the guano outlay, the matter there ended. It is probable that guano will be a valuable resource in the winter cropping of cabbages, turnips, kohl rabi, and such crops, as a stimulant, and that it will pay well for the application. It is best applied in moist weather, and should be mixed with thrice its weight of charcoal, peat ashes, or fine soil, for roots and green crops, or of salt when applied to the cereals. It has been applied with profit to turnips, mangel-wurzel, potatoes, kohl rabi, cabbages, carrots, parsnips, beans, peas, vetches and other pulse; to the cereals, and to maize; but I do not propose to extend its use in my course beyond the winter cropping of the two fields before-mentioned, having greater confidence in home-made manure. Guano is to be kept from actual contact with the seed of the crop for which it is applied, otherwise it may destroy it.

Salt is beneficial in husbandry, and is essential to animal and vegetable life; though, perhaps, its effects have, in some cases, been over estimated, and some statements concerning its results require confirmation. Even in Roman husbandry Pliny records that cattle had a liking for salt pastures, and that cows grazed in them gave more milk, and that too of better cheese making quality, than cows fed on insaline lands; which I think likely, because, as is well known to graziers, animals eat heartily when they are in them; and cowkeepers have long been aware that well fed cows yield much more milk, and that too of better quality, than cows which are badly fed. The feeding qualities of well drained salt marsh pastures are so well understood and appreciated that they always command a high rental value; and

I can instance a case within my own experience in which I turned a hunter, who had seen much service and was very poor in condition, into a salt marsh pasture, in Holderness, on the 1st of May, which became so fat and sleek by the 2nd of August following, that I had some difficulty, when I went into the marsh for the purpose of bringing him home, in satisfying myself of his identity. He was restive in temper and a shy feeder, and had, therefore, never before carried much flesh, but the Holderness pasture, in three months, made him too fat for work, so that he had to be gradually reduced in condition for the hunting season, when he came out a new horse, and outdid his former fame. I attach importance to this instance, because I am satisfied that the pasture had more to do than the animal in the change. Holderness is not a cheese making district, and as I have never fallen in with any salt marsh cheese making farm, I am unable to corroborate old Pliny's statement; but it is no uncommon thing in Cheshire, which is the great salt producing county of England, to top dress pasture land with compost in which refuse salt is a considerable ingredient; and dairy cows milk better upon such land after the application than they did before, and eat greedily of that pasturage which they had rejected in a rough state. Holderness had, however, some first class salt marsh butter dairies, but it was thought advisable, in the best managed dairies, to alternate in pasturage between the best marsh grass and seeds and other herbage, to keep cows from getting too fat, and running prematurely to beef. In English husbandry damaged hay and clover is frequently salted to make it acceptable to cattle, who eat not only the salted hay and clover, but also straw mixed with it, more eagerly than they do better hay not salted, and thrive better upon it. Sir John Sinclair states, in his Code of Agriculture, that when he visited the occupant of a large farm in the Netherlands, he was surprised to find a quantity of rock salt from Cheshire, and three reasons were assigned for its use:—1st, that by allowing sheep to lick it the rot was prevented; 2nd, that his cattle, to whom lumps of it were given to lick, were thereby protected from infectious disorders, and cows were rendered more healthy, and, by being induced to take a greater quantity of liquid, gave more milk; and 3rd, that a small quantity, pounded, was found beneficial to horses when new oats were given to them, if the oats were at all moist. In America salt is given to milch cows, oxen, horses, and sheep, and its importance in husbandry economy is there much higher estimated than it is in British husbandry; and I have to call attention to the belief that salt is highly beneficial in cotton culture, and that some authorities hold that the great superiority of Sea Island cotton is the result of saline influence. In Spain salt is given to sheep, to the extent of 128lbs. a year to every thousand sheep, in accordance with the regulations of the incorporation in charge of the immense travelling Merino flocks of that kingdom; and I may state that salt is formed in Spain by evaporating sea water, a process to which its climate is as favorable as is that of Portugal and Sardinia, where a like process is pursued. Australia therefore, which possesses the like climate evaporative facility for the manufacture of sea salt, need never be without it.

When irrigation machinery shall be matured it will probably be found that salt ponds may be artificially formed to supply the pasturage of the

domain with its modicum of salt in a liquid state; and though the operations of art are of necessity on a small scale, a great result may, nevertheless, be induced by the attempt to follow up such a course systematically. Salt certainly gives sapidity and relish to grasses, hay, and other kinds of raw food, but unless it is supplied in small quantities it may be injurious. I do not propose to apply salt either to the cereals or in my arable course, (save in the way of experiment, or for some especial object which may present itself, in the working of the course,) because from the vicinage of Victoria to the sea, and the attraction which its central mountain ranges will always have for the clouds of its locality, which may be supposed to be more than ordinarily surcharged with saline matter because of their newness, a moderate supply of salt will be received in combination with the rain of such clouds. Moreover, the atmosphere of a country, having more than six hundred miles of sea coast, will, at times, be impregnated with much saline matter from the sea spray, which it holds in combination, and which is impelled downwards to the earth along with falling rain.

It is not, therefore, that I undervalue salt, moderately used, as an arable fertilizer, but because I see, in the favorable position of South Victoria, a constant, and probably a sufficient, source of atmospherical supply (without either thought or cost), for the southern moiety of the colony, that I have refrained from prescribing its use in my arable course As, however, the northern moiety of Victoria will, at all events, lack spray supply, and as its rain will probably be less saline, by reason of its greater rarefaction, consequent on increased altitude, I shall subjoin the following remarks of writers on the subject, which I consider judicious.

Mr. Hollinshead, who wrote on the importance of salt as a manure, and recommended sowing six bushels per acre on meadows after hay was got in, particularly in dry and hot summers, and upon limestone and sandy soils, observes, that the moisture which salt attracts and retains powerfully assists vegetation, and produces a crop greatly superior in quality to that obtained by the application of dung. For meadows he states it to have been found an advantageous practice to mix 16 bushels of salt with 20 loads of earth per acre, turning over the heap two or three times that the substances in it may be thoroughly incorporated, and spreading it on the surface either in summer or spring.

Mr. Rham, in his Dictionary of the Farm, thus writes.—"Sea salt has been extolled and decried at different times, owing probably to the different circumstances under which it has been tried. In a very small quantity sea salt may have a beneficial effect on the soil. Urine contains a great deal of it, and in the formation of composts sea water has been found to hasten the putrefaction of the animal and vegetable matters which they contained, probably by absorbing moisture, which is essential to putrefaction. Quick lime, slacked with sea water, and mixed with sand forms a mortar which attracts moisture so strongly that walls built with it are scarcely ever dry. This suggests a mode of supplying the soil with moisture, and may account for the effect of salt in particular cases."

Marl and unctuous clays will have, ere long, such extensive application in

Australian husbandry, as correctors of the sterility and annoying propensities of loose sands, that I feel called upon to allude to that application. It is my opinion that if English Norfolk had been a county of average natural fertility, it would not have reached the agricultural distinction which it has; forasmuch, as is well known, the men of Norfolk were compelled by necessity to search for the elements of fertility elsewhere than in their surface soil; and were lucky in finding them beneath it, and thereby induced a marvellous result. The necessity for binding the loose sands of Australia, to prevent their annoying combination with hot winds, will impel a systematic search below the sands for the means of binding their surface; and both below and above them for irrigation water, to transform a desert into an oasis, which is, I apprehend, within the scope of human agency, though control of the winds is not.

There is too much puff and mystery about *artificial manures* to be satisfactory to me, and I regard them, at best, as mere stimulative nostrums, which, in some cases, under special circumstances, may produce a beneficial effect; but which, in the main, are not worth the money they cost, to say nothing of the disappointment and loss to which reliance upon their efficacy too often leads. A good husbandman, possessed of a fair quantum of live stock, need not be at all dependent on any quack preparation to ensure fertility.

I shall close the subject of manures by the statement, that, having advised the limeing of the two clover leys in rotation for wheat, and given preferential shares in the homestead manure of the year to the potato field, and its companion field in green-crop rotation,—an arrangement which provides that a moiety of all the tillage land shall be every year either limed or manured,—I think it right, in consideration of the heavy cropping of the prescribed rotation, and to meet the drafts upon the land consequent on the repetition croppings of the cereals, and of the catch or extra cropping of the potato field and its companion field, to suggest a liberal application of guano or of poultry dung as a winter stimulant for the land in cabbage, turnip, and winter brassica cropping ; and of a winter, as well as a spring, application of homestead manure to such parts of the two lastmentioned fields as do not get a guano application (if the circumstances of the cultivator will permit), it being but reasonable that double cropping shall have a double allowance of manure. I advise the occasional application of gypsum to the land intendedproduce to peas, beans, vetches, gramme, lentils, and other pulse ; and of homestead manure to the land producing maize, buckwheat, sorghum, hemp, flax, millet, and the other cropping of that moiety of the field ; and as often as it can be managed the application of charcoal or wood ashes as the top dressing of such of the cereals, barley, rice, oats, and rye as cannot have irrigation, with the view of keeping them cool and of regulating their supply of moisture, and if the supply of charcoal or wood ashes will sanction a consignment to the wheat fields also they will pay well for it ; though, as wheat roots deeper than the other cereals, a top dressing of a compost of chalk mixed with night soil and

urine, applied in moist weather, to impart strengthening aliment to the young wheat, and induce it to shade the soil by its favorable habit of growth, might be even better than charcoal. If gypsum happens to be plentiful it may be very profitably applied as a top dressing to the clover fields, and if all that I have suggested can be managed it will be obvious that every crop of my course may have its appropriate application. I have known land in England over manured, and, as a consequence, deteriorated in value for sometime by the bad habit of producing straw in excess, and forgetting that grain also was wanted ; but whatever may ail the eight tillage fields of Agraria Domain, I have, I think, in my eleven crops in eight years, with their cereal supplementings, provided effectually against their ever being endangered by the disease of muck-plethory, unless manure is wastefully applied to an extent sufficient to produce that disease. The three extra crops to which I have alluded are the catch clover, the winter brassicas, and the winter roots. I have avowedly aimed at exacting as much produce as land of first-class staple can be induced by high farming to yield, but I have also aimed at providing that land with a regular and well-timed succession of substantial and befitting aliment. The eight fields, being the mainstay of the stock department, have right to two-thirds of all the homestead manure ; and the special culture department ought to have the remaining third in exchange for its equivalent in purchased manures. In regard to the special culture department I have to explain that cotton-plant refuse, duly prepared, will be a good manure restorative to cotton crops, and that, on true chemical principles, vine plant refuse will be a beneficial application in vineyards, and that such a plan is eligible in all special culture cropping in aid of other manures. The permanent pasturage will get some cattle droppings, and ought to have in addition periodical top dressings of compost, alternating between dunghill compost and compost in which lime, or some such fertilizer, is the efficacious ingredient. I am favorable to the application of salt on pasture land.

It will be advisable to have a sunken manure depôt, with a branch liquid manure tank attached, near the junction of the northern tramway, with its east and west branches, and a similar depôt and tank near the junction of the southern tramway, with its branches, in order that the carriages sent out for soiling produce may take with them solid manure from the homestead depôt to such of the branch depôts as they have to pass. Such a course may save much carriage bustle at busy times, and it will not, I apprehend, be difficult to protect the body of the carriages from pollution by some contrivance in the shape of a washable water-tight wrapper, liftable, with its contents, by a mechanical power, out of its carriage, and shot into the receptacle of the branch depôt, much in the way in which, when sailing up the English river Tyne, I saw Newcastle coal shot from the banks of that river into the vessels intended to convey it out to sea.

In regard to the geological character of soils, I have to explain that I construed the words having reference to that subject, in the announcement for the Essay, as intending that the husbandry propounded should be in accordance with general geological principles, and not as intending that

the Essay should assume the province of a treatise on Victorian soils and their adaptation to particular crops. The comparatively small extent to which the geological survey of the colony has as yet reached, and the paucity of material as yet gatherable for due elucidation, suggested that construction, and confirmed me in it. I am, moreover, of opinion, that the effect of the onward move in agriculture, which, "practice with science" is impelling, will be to displace many of the trivial lines of demarcation hitherto subsisting between particular soils and particular crops; and that the terms "wheat land," "barley land," and "rye land," &c., &c., &c., hitherto used as indicative of special adaptation for particular crops, are already antiquated, and will soon become so obsolete as that it will not be necessary to import them into the husbandry phraseology of Australia. The farmers of Essex demonstrated long ago, that very strong soils would, if worked to a fine tilth, produce first-class barley: the farmers of Norfolk had before that shown that loose sandy soils, formerly deemed unfit for wheat culture, would, by the application of lime and a clover ley preparation, produce noble crops of first-class wheat; and in regard to rye I have often noticed, when tithing fields (in primitive English districts, where the old monkish admixture of wheat and rye continued to be sown on strong clays), such fine heads of rye, that I was led to the conclusion that if I ever grew rye for the purpose of distillation it should be on soils of medium staple, as more likely to be predisposing to potency than the rye grown on a sandy soil. Why, therefore, when nature is so ready to level her own barriers, and to open her vast domain to husbandmen who march under the banner of "practice with science," should agriculturists unnecessarily adhere to inconvenient distinctions, which nature has herself indicated willingness to abolish.

Soils are, as is well known, the debris of the rocks and earths which underlay them, and they, of course, partake largely of the properties of the underlaying substances, chemically modified, however, by many years of atmospherical exposure and by other influences, and improved by vegetable accumulation. Volcanic agency has in many Victorian cases so fused, and, as I will term it, chemically cooked the soils of several favored localities as to have made them ready for use, with predisposition as well to fertility as to universality, in any cropping range; and I assume that grantees will take care to be well advised as to the quality of the land which they take up under the Land Act boon, and that first-class land only will be taken up so long as it is findable within the purlieus of population unappropriated.

Agricultural chemistry teaches that productive soils combine largely *silica* (sand), *alumina* (clay), *humus* (or organic matter), and lime, and that they combine also, in lesser proportions, the oxides of iron and manganese, magnesia, potass, soda, phosphoric acid, sulphuric acid, and chlorine; and it is the triumph of modern science to be able, in many cases, by correcting the proportions in which they happen to have been in the first instance combined, to effect great improvements in the texture and productive power of a soil, but inasmuch as that is better which requires no mending than that which does require an operation to make it good, I incline to the opinion

that, until first-class land becomes scarce, colonists intending to pursue agriculture for a livelihood will do well, while they have abundant choice, to eschew land which wants any doctoring, and that, therefore, consideration of the geological and chemical character of the soils of Victoria may, without detriment to Victorian husbandry, await a call under the federal auspice of all the colonies for a simple and well defined nomenclature of all Australian soils as a common standard. In the meanwhile I apprehend the following classification will suffice to meet the purposes of this Essay :—

1. Clayey Soils.
2. Sandy Soils.

} Those in which the ingredient named predominates.

3. Clayey or Strong Loams.
4. Sandy or Light Loams.

} Those in which the clayey and the sandy ingredients combined are mixed also with *humus*, assigning the generic name to the ingredient which predominates in the loam.

5. Limestone formations.—Which were favorites with me in England, and are likely to be more so in Australia, because of the subsoil capacity of the best of them to retain moisture, and the regularity with which they give it out on surface excitement. They have, however, the drawback of being deficient in surface water springs.
6. Gravelly Loams.— Popularly called in England turnip and barley soils, and thought much more of in that humid climate than they are likely to be in the dry climates of Australia, save where irrigation is practicable.
7. Volcanic Soils.—Which I am glad to find abundant in Victoria, because of their great fertility.
8. Chalky Soils.—Which I am not sorry to learn are likely to be among the geological rarities of Victoria, because they would be here too arid for even sheep pasturage.
9. Peaty Soils.—For some purposes very desirable.
10. Alluvial Soils.—Generally the most fertile of any.
11. Mixed or Patchy Soils.—In some cases capable of great improvement when the price of labor will allow.
12. Sandy Districts.—Too loose for cultivation without adventitious aid.

NOTE.—The 3rd, the 5th, the 7th, and the 10th of the foregoing list may, as a general rule, be classed as first-class staples, as may also the 4th, if it happens to overlay either a marl or a genial clay.

Fencing is too important an object in husbandry to be passed over without notice even in a mere essay, though some years will elapse before living fencing can in Australia become general. The result of my own English experience (which has been extensive) is, that an admixture of prickly holly with the hawthorn, in the proportion of two hawthorns to one holly, makes the best of all growing fences In regard to the hawthorn, great mischief has resulted from the inconsiderate assertions of early Australian writers, that it became here too delicately spiked to be of much use in fencing. I observed whilst in England the statement to that purport, which happened to have got into print, so often reiterated in subsequent

publications, that I concluded the fact was as stated, and that conclusion had a detrimental effect in my particular case ; for when I was packing to come out, having an unoccupied space in a rough package, I should have filled it with berries from a favorite hawthorn seedling which caught my eye at the moment, remarkably prolific as a bearer, and more than usually rough and spiky in its habit of growth. I was, however, deterred by the recollection that as the hawthorn would be useless as a fencing material, I had better fill my space with something else, and I did so. It happened however that during my sojourn in Adelaide I observed in a neglected garden a considerable length of an old hawthorn fence, which I had the curiosity to examine, and I was agreeably surprised to find it as prickly and efficient as it would have been in England, as the scratched state of my hands after the examination amusingly testified. There are many willow-like varieties of the hawthorn in England, and most of the double-blossomed and the peculiar varieties, propagated by budding and grafting, are such, and I have no doubt but that the variety first grown in Australia happened to be of that character. The mischief in my case was however done, for I had the mortification afterwards to learn that my English successor, thinking my seedling too rough a tree for the position which I had assigned to it, had it cut down ; and though I shall give to my English friends strict injunction, in gathering the berries both of the hawthorns and the hollies, which I am intending to import for Australian seed, from trees of rough and prickly habits of growth, I may be long before I produce another seedling hawthorn so eligible, as an experimental seed grower, as the one which I have so unwittingly lost. There is no effect without a cause, and it is my belief that nature will not be coy with inductive enquirers as to the causes of many of her effects, and that she will aid Australian husbandmen in their endeavors to establish and perpetuate peculiar properties called for in the adaptation of English hawthorns for Australian fencing. I noticed, when in England, that tall free growing quicksets (as seedling hawthorns are there called) were generally less prickly than those which were of slow growth and stunted ; and I have observed in Victoria that quicksets are occasionally sufficiently prickly in their bottom and horizontally growing branches, whilst their vertical branches (which indicate greater rapidity in growth) are less prickly and efficacious than the horizontal ones of the same plant, from which I am inclined to infer that, as the bottom of a hawthorn fence will be its most important part, young plants should be retarded rather than quickened in growth until horizontal training shall have reached a given height. Gorse, blackthorn, crab-apple, and horn beam, which are in occasional use in British fencing, are so much inferior to the hawthorn and the holly that I never sanctioned their use in England, and I cannot therefore advise their introduction into Australian husbandry. There are several varieties of the holly which are unspiked, but these will of course be avoided in Australian introductions. The holly is a plant easily reared, and is possessed of great vitality and longevity. I raised thousands yearly for many successive years as easily and cheaply as I did hawthorns. The holly will be of quicker growth in Australia than it is in England, and it will therefore on that account here escape the only objection which I

ever heard urged against its general adoption in English fencing. The prickly accacia, the prickly cactus, the Cape broom, and some other plants, which I have seen applied to fencing purposes, both in South Australia and in Victoria, are nothing to be compared to the holly and the hawthorn for substantial fencing, and I shall therefore enjoin a plentiful introduction of holly and hawthorn seed berries by every opportunity, until Australia shall produce its own supply of seed.

English farmers of strong land will perhaps think that I have overlooked necessity for periodical summer *fallowing*, but such is not the case ; for that subject has had much of my thought, and I have arrived at the conclusion that in Victorian husbandry fallowing need not be periodical, as in England. The climate of England is so humid, and the soil is generally so saturated, that it is only in midsummer weather that strong soils are there dry enough to be effectually worked and cleaned. Hence arose the English practice of summer fallowing, which afterwards gave rise to the custom which regulated the right of outgoing tenants in the wheat crop of the harvest following the expiry of their tenancies, and which required as a condition that the first ploughing of the fallowing process should precede midsummer day. The introduction of fallowing formed an era in English husbandry, and was productive of good ; but intelligent farmers at the commencement of the present century began to question the necessity for sacrificing triennially an entire year's cropping, merely to clean and rest their land, and the question ended in the ascertainment that the supposed necessity for rest was a fallacy, and that feeding the land with manure was of greater avail than a fallow rest. By degrees midsummer fallowing gave way to prompt spring management, and the practice is now so obsolete that the apologists for an occasional full fallow only plead climate necessity for a pulverize which is rarely to be had in England save at midsummer. Now, it luckily happens that the genial climate of Victoria affords such ample opportunities for thorough pulverization and working between crop and crop, and the soil is so often, even in midwinter, so dry and workable, that, save in the thorough subsoiling operation necessary on bringing land for the first time under cultivation, I have come to the conclusion that no cropping need be sacrificed to secure in Victoria the purpose of an English fallow, at least twice, during my course, as I will show. That course starts with wheat, and between wheat harvest and the first potato setting and the first green crop planting, several months intervene, and if the autumn should happen to be wet, the probability is that the spring would be dry. Four years afterwards wheat again recurs in rotation, and affords a second and a similar opportunity for a thorough working and cleaning ; and, in addition to both opportunities, advantage may be taken of the interval between the oat and rye harvest of the seventh year and the pulse seedness of the eighth, to do anything further which the state of the land may require. Those considerations led me to reject fallowing, in the English signification of the term, in my course, as a periodical interloper in cropping season.

In regard to *draining* also, Victoria is, happily, better circumstanced

than England. inasmuch as evaporation goes on so steadily and rapidly that the soil is never saturated for any great length of time, except where impediment impounds water up, in consequence of which systematic underdraining is not the essential preliminary which it is in England to first-class Victorian husbandry. A few judiciously placed surface drains, with subterranean levels to carry off flood waters, aided by thorough subsoiling leavenings of the under soil, induced by the admission of atmospherical influences, under the powerful agency of machinery impelled by steam, will be a much cheaper and a more efficacious measure of Australian fertility than British draining operations, masterly as they have become. The draining skill of Victoria will be, in great measure, confined in scope to the drainage of bogs and swamps, and as an auxiliary subservient in irrigation. Viewed properly that circumstance is an inestimable advantage to the landowner, because it relieves him from an immense outlay at the commencement of his operations, when the conservation of his capital is to him a greater object than at any subsequent period of his career.

The *political aspect of Australia* is as favorable to its husbandry as is its climate, for though Australia shares with the mother country in the blessings of British law and British liberty, it is happily without the incubus which participation in the national debt and in the taxation which has always, in England, been heaviest on the agriculturist and his land, would occasion. Neither tithes nor tithe composition, nor land tax, nor income tax, nor rates for the repair of the church, nor highway rates, nor statute duty, nor county rates, nor poor rates, nor any of the many such like voracious demands on British husbandry, attach upon that of Australia, save in a few exceptional cases; and though I have been an Australian three years, the only tax outgoing which I have been called upon to pay, has been an annual rate of a shilling in the pound on my rental amount, which covered all purposes for which I was liable; and if, as far as the Colony of Victoria is concerned, its too many legislative cooks had not spoiled its recently passed Land Act, it might have been a model for that of other colonies, instead of being the unsatisfactory measure which it now is, demanding much amendment before it can be considered equal to its occasion.

The introduction of a cheap and simple mode of conveyancing and dealing in matters regulating land ownership without necessity for the intervention of professional men, would be an Australian blessing It happens that the two English Land Agency Offices in which I spent successively thirty-six years of my professional life, were both of them remanents of an old English practice which combined law and land agency, (for up to the commencement of the present century, nearly all the larger landed estates of England were under the agency management of attorneys); so that having had more than an ordinary share of legal and conveyancing experience, I am competent to give an opinion on the practicability of such a measure. There are very serious faults in the South Australian scheme of Mr Torrens which overbalance his salutary provisions. The stability of a rock, rather than the impulsive movements of a rudder, should have been at the bottom of his scheme, and his

pervading object from first to last. His intentions were better than his legal skill, but his design of adapting ship conveyancing, applicable only to that which is proverbially the most veering of all property, to land, was so erroneous and whimsical in conception that many of his pet provisions will have to be thrown overboard before his measure can be pronounced safe; though some of his aims were good, and may, with the valuable aid afforded by the recent labors of the Imperial Parliament in that direction, enable colonial legislators to mature a measure by which officials entrusted with its working, shall, for a moderate fee, give effect to the intentions of vendors and purchasers, mortgagors and mortgagees, lessors and lessees, by simple, but valid documents, prepared and perfected at a single interview, if all necessary parties and previous documentary links in the title are forthcoming, so that professional cost need attach only on special occasion.

I happen to have had too much troublesome experience in English commonage matters, to be sanguine as to the result of any introduction of that system into Australian husbandry; for, in addition to the monition of the spectrums visible to my mental eye whenever I rode across an English common, in the semblance of horse and cattle stealing facilities, the costly working of an annoying impounding system, the instinctive cunning of the stronger and best tended herds to monopolise the best feeding places, the absence of conscience in too many of the parties exercising commonage right, and the danger to which animals coming into contact with contaminating disease were exposed, I see and hear on Australian commons that dire object the pleuro-pneumonia croakingly forbidding prudent men to avail themselves of the very trifling benefits promised by a system unworthy of adoption even in a golden age, but fraught with peril in the iron one which is now current.

As a sound policy in the landed economy of a colony, is the best base on which its husbandry can rest, I am inclined to advise, in the case of Victoria, the restoration of the provision in its Land Act, which carried deferred payments over a longer period than was in the sequel adopted. Many cases suggest themselves to a land agent of experience, in which the fourfold arrangement would have been a great boon; and, as the Government retained the fee of the land until it should be actually paid for, it did appear to me that the boon might have been granted with safety to the community. The disposal of contention in claim by two parties applying for the same section, by lot, which the Act in the first instance proposed, was much more consonant with English law than the system of limited auction, which was intruded in its stead, and I much marvelled that during the discussion on the clause no advocate for lot arrangement reminded the public that the auction system was not of English constitutional growth, as was supposed, but was a mere modern outlandish graft, barely a century old, which the East India Company had introduced into English practice for the disposal of their merchandise; whilst, on the contrary, lot was accordant with English law, a thousand years before that introduction. Moreover, as the spirit of the Act evidently intended that all claimants should have equal chance, it was inconsistent to lengthen unconscionably the sword of a wealthy antagonist, where the Act intended contending parties to have that equal chance. The penal clauses of the Act were both badly conceived and badly expressed. No right-minded man will object to being

bound to a given expenditure within a given period in the erection of a homestead on his section, and in its cultivation, by himself, or his tenants, or his servants; but to compel him to reside on it in person was interfering as much with his personal liberty, as the restriction upon his cultivating the leasehold part of his domain did, in regard to his legal right to pursue the course best adapted to accelerate the development of the productive capabilities of that land which was shortly to be his own in perpetuity. If the colonial purse had been bound to compensate in the event of failure, I should have seen a motive for the prohibition. but, as the Act expressly repudiated compensation, I could never comprehend the why and the wherefore of this prohibitory regulation. The time has, in my opinion, arrived for the application of well considered leasing powers to any part of the unalienated land of the Colony of Victoria, and especially to what are generally called squatters' runs. A geodetic square of 25,000 acres, appears to me to be, in the present stage of the colony, a convenient size for a maximum run, and an eighth of such a square, a convenient minimum size. The term of years and tenancy terms, will of course be matters of legislative and executive arrangement, and though it might be improvident to lock up for a long term runs of greater extent than a geodetic square each, there is no reason why the pastoral interest shall be unnecessarily crippled, or why, so long as land is abundant, squatters owning large flocks shall be confined to one run. The great matter will be the exaction of a fair rental revenue up to the time the land is either wanted for higher occupation purpose or to pass into private ownership. As Victoria is fortunately to have only the two tenures of freehold and leasehold, it follows, that the distinct scope of each should be clearly understood, and that leasehold rights should be well-defined at their creation. The Colony possesses so many husbandry advantages that when its Land Act shall have been amended, and the importation of British labor shall have been considerately regulated, it cannot fail of becoming popular among British husbandmen and British laborers of the rural districts, when a speedy development of its agricultural capabilities will ensue.

Educational institutions like that of Cirencester in England, and agricultural professorships like those in the English universities of Durham, &c., and peradventure also some of the modern arrangements of European continental establishments for the systematic development of landed economy, ought to be among early Australian provisions for the purpose of training youth for the dignified exercise of the most venerable of all professions, for such is in reality that of husbandry, inasmuch as no fraternity can produce a charter which can vie in origin with that primal one of the earth, granted to Adam, the first husbandman, in that ever memorable fiat of Deity: "Be fruitful, and multiply, and replenish the earth, *and subdue it*; and have *dominion* over the fish of the sea, and over the fowl of the air, and over every living thing that moveth upon the earth. Behold I have given you every herb bearing seed, which is upon the face of the earth, and every tree, in the which is the fruit of a tree yielding seed; to you it shall be for meat." And though the agricultural profession has had the ill luck to be thought less exaltedly of in England than it was in ancient Rome, it has nevertheless added to the plume of British greatness one of its best developed feathers; and I shall take the

liberty of stating, that I have yet to find a profession either more deserving of encouragement, intrinsically, on its own useful account, or more learnedly interwoven with general science, than that of first-class husbandry; in which zoology, botany, mineralogy, chemistry, geology, physics, and the sciences which regulate heat, light, electricity, water, air, and a host of atmosphericals; architectural and mechanical, structural applications, and the principles which govern the construction of machinery, implements, and utensils; anatomy, physiology, cattle medicine, and entomology; astronomy, in its regulation of the seasons; and geography, in its statistical details, as to the habitats of animals and plants, and the localities of fertilizing substances; and many other branches of exalted science, and applications of superior manual skill, are mere contributory constituents: and yet, I am not aware that either professors or lecturers in any branch of either landed or agricultural economy pertain to any Australian collegiate establishment at present in existence. This is not as it ought to be; and I must remind Australians, that however important dead languages and abstruse investigations may be on some occasions and for some purposes, and that, however assuming political and statistical matters may be in their demands on the public purse, the due development of the agricultural resources of their new country is paramount in importance to any of them; and that at the present time Australia has greater need of foundations which shall produce intelligent practitioners in a path of usefulness, on which the footsteps of Jethro Tull, Arthur Young, William Marshall, and Sir John Sinclair, Bakewell, the brothers Colling, Tomkins, Culley, Ellman, and many others, have left an impress of dignity, than it has, as yet, for those which are to produce Australian Adam Smiths and Jeremy Benthams.

So far as Victoria is concerned, I hail with satisfaction the recent establishment of the Acclimatization Society of Melbourne, which may be made a powerful auxiliary, not only in the domestication and increase of useful zoologicals, and especially of quadruped ruminants from every region of the earth, but also of placing, at moderate cost, within the reach of intelligent breeders the blood of any animal wanted to impart greater perfection to the flocks, herds, studs, and collections of its kind, pre-existing here; thereby adding to the excellence of our stock and increasing the pastoral wealth of the colony. And I also hail with satisfaction, though with a degree of expectation somewhat less sanguine than in the other case, its recently established Horticultural Society, because I fear that the useful will be made too subservient to the pleasurable, and that flowery and showy trivialities may receive greater attention in their development than the acclimature of useful vegetable introductions, and the formation of varieties specially adapted for Australian culture, which ought to be its chief care.

Victoria may fairly indulge pride in the contemplation of the Botanic Garden at Melbourne, which has already yielded valuable scientific fruit, and is full of budding promise. I cannot conceive a finer field for intellectual enterprise than that which Dr. Mueller is so profitably cultivating; he can with truth exclaim, in the language of Holy Writ, "The harvest truly is great, but the labourers are few." Notwithstanding the number of plants to which I have called attention as worthy of Australian culture, I think it within the pale of probability that Australia possesses indigenous types of the greater part of

them, and that the soil and climate of Victoria will enable scientific cultivators to expand, in the course of years, those types into varieties, and, peradventure, species, worthy of European attention.

The astronomical and atmospherical establishments of Victoria are conducted on true inductive principles, and are already producing valuable fruit To them I would confide the series of climature ascertainments in various localities, required to decide their mean climate heat, and to point to where the intelligent husbandman may delve to the best advantage in the culture of the more special of his products. A well arranged floral kalendar, which shall adapt the seedness and harvest periods of Victorian cropping in a dozen standard localities, to those of London, Edinburgh, Dublin, Paris, Rome, &c., &c., &c., and the various regions in which introduced vegetables have had their best cultural development, would be worthy of the joint labor of Dr. Mueller and Professor Neumayer, and ought to have immediate attention

The establishment of agricultural libraries in every county town of a colony is an imperative duty in a new region, in which two-thirds of its immigrant population betake themselves to the exercise of a calling in which they have had no previous instruction; but as most of them (thanks to the educational philanthropy of the nineteenth century) can read, there is that mode by which adults who have to earn their bread before they eat it may glean a few heads of agricultural experience for their guidance. Whatever induces thought is sure to be productive of good, in any field of labor; and as the age of miracles and miraculous intervention has passed away, the best mode of arriving at knowledge in the ordinary course of things must be resorted to.

Written law is not more essential to the lawyer than is written agriculture to the agriculturist; it luckily happens, however, that the georgical literature of England is peculiarly rich and valuable, inasmuch as the inductive observations of our sagacious British forefathers have been so well recorded, and subsequently commented upon by Young, Marshall, and Sinclair, and their worthy coadjutors of a past age, that we inherit in our mother tongue, which appears to be the predestined living language of the world, material for a code of Australian agriculture, as comprehensive in its scope as the importance of the region demands. Recourse may be had to the writers of France, Italy, Spain, Germany, and some other European countries, and to the writers also of America, as to matters out of the pale of British husbandry; and great benefit might result from judiciously compiled treatises on the various products which I have proposed to include in Australian husbandry, and such other products as may be added to my list. And when it is considered that the English language is already that of Australasia, and will be soon the general language also of India and of America, and the African settlements also, and that all the places mentioned are either already or soon will be embarked in agricultural pursuits, a vast field is opened for the periodical interchange of agricultural information, and the circulation of an agricultural journal worthy of Australasia, and of a series of practical treatises on the more important products which all will be, more or less, engaged in cultivating.

It has frequently occurred to me whilst composing this essay, which may, (when expanded into a practical treatise of six times its present bulk), probably

entitle me to the fathership of systematic Australian husbandry (inasmuch as it propounds an entire system whilst all the Austral and Anglo-Austral agricultural publications which have come under my notice, have been limited in their scope to one particular object, as for instance, the vine and its culture, or some other such special product); under what different and discouraging circumstances Sir Anthony Fitzherbert, an English judge, produced, in the despotic reign of Henry VIII., the father book on British husbandry, which he published in the year 1534, and probably wrote, amid the bleak and then cheerless scenery of Derbyshire, as the manual of a nation which then fell short in productive capacity of that of his own bleak shire 300 years after his book was written; what an insignificant notion he must have had of the dignity of his subject in comparison with that which greeted my eye in the course of an actual survey, extending over time amounting in the aggregate to three years, which I took of the agriculture of the fifty-two counties of England and Wales, after the Royal Agricultural Society of England had begun its noble march, under the banner of "practice with science," which is so wonderfully expanding the ramifications of Sir Anthony's little oak.

Sir Anthony's conception, when he put his acorn into British ground, was probably bounded in its northern scope by the River Tweed, but it could not, under any circumstances, have carried him in vision beyond the ever venerated shores of Britain and Ireland, and his products would be limited to the few starvelings of the vegetable world then known to him; whilst my little pet, "the Victorian seedling," may possibly, three hundred years hence, overshadow a region almost equal in size to Europe, and greatly exceeding even that highly favored quarter, as a whole, in climate advantages, producing, in one district or another, in the open air, highly developed varieties of "every herb bearing seed which is upon the face of the earth, and every tree in which is the fruit of a tree yielding seed," and may though the last discovered region of the earth, probably, owing to its free institutions and the energy of its sons, have enabled Australia to be, in consequence of its having surpassed Europe in the extent of its cultivated flora, the first of the five great divisions of the earth, entitled to claim Adam's husbandry charter as an heraldic trophy.

In developing their Australian germ, the expatriate sons of "garden cultured England," have ample scope for their inductive energies in the subjugation of the devastating vagaries of unregulated heat, and the taming of sirocco brickfielders: the bringing to the surface subterranean water, and conserving and distributing the supply already there; the reduction of insect rapacity and annoyance, and estopping their myriadfold ratio of progression by the introduction of counteracting zoological inimicals; and the importation of such animal and vegetable subjects of nature as will best subserve in securing for Australia a greater range in the agricultural economy of his dominion than has fallen to the share of any one of his four elder compeers in the government of the earth, which have all been committed to their charge as a responsible trust, by the mother country, and as almost the only condition annexed to the boon of self-government and the noble heritage of British law, language, and liberty, which is now their irrevocable right for ever.

It is, however, cheering to know that much less thought, skill, and cost, will effect miraculous changes for the better both in regard to hot winds and to

water supply, than their British forefathers were called upon to bestow in their climate contests with ruthless frost, and in relieving their land from the pernicious consequence of excess in that surface water which is here coveted. Numberless and incessant were the well-directed efforts of English farmers, before the dairying of Cheshire, Gloucestershire, Wiltshire, Somersetshire, and Devonshire; the hop-culture of Worcestershire, Kent, Sussex, and Surrey; the meadow-floating of Herefordshire, Wiltshire, Gloucestershire, and Dorsetshire; the matchless system of drainage and management which has given to the Fen districts of Lincolnshire, Cambridgeshire, and "the land of the levels" their only passport to value, as good *terra firma;* the warping operations of Yorkshire and Lincolnshire; the masterly tillage of Norfolk, Suffolk, Essex, Lincolnshire, Yorkshire, and Northumberland; the orcharding of Herefordshire, Worcestershire, Kent, Somersetshire, and Devonshire; and many other prime features of English husbandry, which are unfindable elsewhere, drew forth from admiring Europe his plaudit, that England, despite its climate disadvantages, was the agricultural paradise of the earth.

In conclusion, I shall, as the exponent of a course of cropping which brings rice into fellowship as to culture with its kindred cereals, and rye into friendly rotation with pulse; which seeks to exact extra yield from cereal vitality, and proposes to subject even fugitive catch cropping to systematic regularity; which proposes to expand the pre-existent range of zoological domestication into an absorbing system sufficiently capacious to comprise the most useful and profitable of the "living things" of that vast range of dominion which was committed to Adam's care; which projects the union of agriculture with horticulture for the production of a special branch of warm climate culture, worthy of Australian growth, and to become, in after times, the pride of its husbandry; unfurl in Victoria the banner of "practice with science," and, waving it, exclaim. "Advance Australia Felix," and win, by well-directed irrigation effort, the vanship in Australian husbandry, which may thereby become, in perpetuity, thine.

Floreat Victoria! saith "AGRARIAN," on bidding his subject, for the present, adieu.—1st October, 1860.

ESSAY

ON THE

Origin and Distribution of Gold in Quartz Veins,

AND ITS ASSOCIATION WITH OTHER MINERALS,

AND ON THE MOST IMPROVED METHODS OF EXTRACTING GOLD FROM ITS MATRICES.

MOTTO

"PICK AND PEN."

BY HENRY ROSALES, M. & C.E.

P

ESSAY.

It is necessary to a proper investigation of the subject of this essay, to advert briefly to that part of the general geological features of this country, in which auriferous quartz lodes are found. It is a schistose formation of ancient date, having an average meridional strike, and seemingly inter-laminated by auriferous quartz lodes. Auriferous debris, the waste of the abraded auriferous schistose formation accumulated in ancient valleys, now hidden, and thus formed auriferous alluvial deposits of tertiary dates, &c. The schistose formation belongs to the Cambro-Silurian series, and owes its highly inclined position to the upheaval of granite rocks[1] which correspond geologically with the igneous

[1] At Tarrangower the beds of the schistose rocks have been upheaved by the Western granite, and have an Easterly underlay. Some miles further East towards Castlemaine the underlay is to the West, the schists having been upheaved by the Mount Alexander granitic mass ; Mr. Selwyn pointed out the sinclinal axis in 1853. The granite of Tarrangower is very much decomposed—too much so almost to determine its mineralogical composition, which however seems to be the same as that of Fellmonger's Creek, near Ballaarat, which consists of orthoklas in crystals of a quarter of an inch, dark mica of an eighth of an inch, and light brown rhombohedral quartz. The granite of Mount Beckwith contains in general felspar, quartz, and but little mica ; in some instances there is scarcely any mica, it is altogether of a finer grain. The granite mass is apparently intersected by another granitic rock—pegmalite—of a very fine grain. The granite of Mount Cole is similar to that of Fellmonger's Creek, only it is of a much coarser grain, besides containing particles of iron pyrites, and perhaps also a second species of felspar. Gold has not yet been found to exist in any of these granites ; they differ essentially in their petrological characteristics from the granite in which the Rev. Mr. Clarke states gold has been found in New South Wales. The Mount Cole granite, however, might possibly contain gold.

rocks which upheaved the system of Westmoreland, or the most ancient (according to Elie de Beaumont's *Theorie des Sublevations*), and whose protrusion has been nearly in a meridional line,[2] hence the average meridional strike of the schistose strata, which oscillates in different districts up to 60° by compass bearing.

The question now presents itself, are the auriferous quartz lodes which intersect the schistose formation of an older date than the granitic rocks, or the contrary? Geological observations, whether underground or on the surface, present the following facts:—that the auriferous quartz lodes do not continue their course into the granite;[3] that they are abruptly broken off at the point of contact, that they are twisted and turned from their due course, or else broken up into fragments;[4] that the quartz lodes are intersected by granite dykes;[5] that fragments of granite are never found enclosed in the quartz lodes, and that in some instances the quartz lodes have been subjected to the metamorphic action of granite.[6] These facts when viewed logically, prove that the

[2] It is to be regretted that the different compass observations have not been reduced to the true north up to the present time, for public reference.

[3] A fact which may be easily ascertained by examining the districts of Bendigo, Ballaarat, Tarrangower, Clunes, &c.

[4] The contrary would have been the case were the quartz lodes of more modern date than granite.

[5] To the north of Tarrangower, along the limit of the schist and granite, between Bell and Mosquito reefs, several quartz lodes have been thrown out of their bearings altogether; some having an almost East and West course, and being so much broken up, that the miners cannot attempt to work them systematically, being bewildered by the constant running out of the quartz, which they sometimes find again where least expected. Several other quartz lodes of the Tarrangower district which are yet unnamed, are intersected by granite dykes and veins, their contact being marked by large crystals and orthoklas, large crystals of silver-gray mica, some rhombohedral quartz, and crystals of black tourmaline. Such is the case again at the Mosquito and Nuggety reefs, the latter being—according to Mr. Phillips, a claimowner on the reef—a highly auriferous quartz lode of about 10 feet wide, which was intersected at the depth of 25 feet by a granite vein from 4 to 5 feet thick, after which the quartz lode was found again bearing as before, and as before underlaying to the East. In the same reef, at a depth of 140 feet, small granite veins frequently run into and intersect the quartz lode.

[6] The quartz lodes along the Eastern limit of the schist and granite near Fellmonger's Creek, have been changed, as to the state of aggregation, up to about a quarter of a mile West. The quartz is not compact, of conchoidal

quartz lodes are of an age anterior to the eruption of the granite rocks,[7] although there are quartz lodes setting in granite,[8] which on doubtful authority, are said to be auriferous; should this however be the case, it would at once establish that quartz lodes are also to be found in this country of a more recent date than the granitic rocks, and that they are perhaps contemporaneous with those of the Lower Adelong, New South Wales, which set in granite;[9] or perhaps the granite of Adelong is of a more ancient era than the Victorian. These are questions yet to be solved, so that with the present insufficient data it would be premature to hazard any further opinion on the subject. It is clear, therefore, that the auriferous quartz lodes, are unlike most other lodes, which are "crevices more or less vertical, caused by contraction during drying, or by metamorphism, or by mechanical disturbance of a rock, this crevice having been subsequently filled up."[10] They are in their origin anterior to all those forces, some of which accompanied the eruption of granite rocks, and which have been thoughtlessly applied by some to explain the origin of

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fracture or of vitreous lustre; it is of a coarse-grained crystalline structure, snow-white and opaque; at first sight it is forcibly suggestive of Carrara marble. Referring to this appearance, Professor Ansted (page 58) says:—"Quartz rock or metamorphic sandstone is also granular, and is distinguished without difficulty, as well by its appearance as by its geological position, from any rocks for which it might be mistaken." In all probability the close-grained quartz of Tarrangower and other localities has also undergone metamorphic action, the similarity of appearance being attributable to a similarity of causes.

[7] Mr. Selwyn, in a letter (July 13th, 1858) addressed to the Private Secretary, says that "the granite boundary is often for many miles at right angles to the strike of the highly-inclined beds of Silurian rocks, the quartz veins, however numerous, are suddenly cut off on coming in contact with the granite; and no gold has ever been obtained from these granite areas at a distance from their junction with the stratified rocks: the best illustration of this fact is the large granite area which extends between the rich gold districts of Castlemaine and Sandhurst. From the above facts I should infer that generally the quartz reefs are of older date than the granites."

[8] At Mount Beckwith a quartz lode traverses the granite, and at Mount Flagstaff, Linton's, there is another occurrence of the same kind, the quartz there containing iron pyrites, and said to be auriferous.

[9] *Col. M. Jour.*, page 182, July, 1859, also Professor Smith's paper, read before the Philosophic Society of New South Wales in August last.

[10] Professor Ansted.

quartz lodes.[11] The fact that the quartz lodes are of an earlier date than the granite, forces a further investigation of the subject to a remote period of the earth's history, when the granitic rocks, not yet having made their appearance, the Cambro-Silurian beds were still undisturbed in their original horizontal position. The Cambro-Silurian system of this country presents a series of coarse and fine grained sandstone, containing few marks of slaty structure; slaty sandstone of different colors, alternating with bands of slate of perfect cleavage,[12] also of different colors, but generally exhibiting a greenish hue, and white when decomposed. Organic remains seem to be of rare occurrence in this formation, until now it is only in the vicinity of Bendigo that distinct specimens of graptolite have been found.[13] This far and widely spread palæozoic series of rocks—the waste and refuse of the primitive cooling crust of the earth's surface, was deposited slowly, gradually, and without interruption in horizontal beds, which thus attained the enormous thickness they now present during that protracted

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[11] At a meeting of the Miners' Scientific Association (June 22nd, 1858) at Sandhurst, Mr. T. Burrows read a paper which was subsequently published in a local journal, in which he says "that clefts in the rock have been formed by upheaval produced from volcanic action far beneath us and that up those seams hot water and vapors strongly impregnated with silica had been forced up;" and Mr. Thureau (*Col. M. Jour.*, June, 1859), writes: "the upheaval of the older granitic rocks produced the present erect position of the secondary or palæozoic rocks. Fissures of various kinds and dimensions were originated by these tremendous revolutions of the earth's crust. These fissures were filled from below with a silicious solution, which refrigerated gradually, and forms the interesting mineral quartz." Passing over the exceptionable expression, "secondary or palæozoic rocks," and the somewhat premature one, "older granite rocks," even should the close-grained felspar rock of Mount Beckwith, &c., prove to be a newer granitic rock, it is to be noted how alike are these two theories which, at variance with established geological facts, would go to demonstrate that quartz lodes are of more modern date than granitic rocks.

[12] At Bendigo there is a band of slate from which tiles and large flagstones are obtained; and at Specimen Gully, Barker's Creek, flagstones of great size are also to be met with.

[13] At Bendigo distinct specimens of graptolite are found at Paddy's Gully reef, and even along the walls of the lode near Whip Reef and other localities; the finest are found in the slates of the slate quarry, where the original lines of bedding are apparently very slightly traversed by slaty cleavage, which is parallel to the strike. In the Ballaarat and other districts, there have been no traces of organic remains found up to the present time.

period, when peculiar cosmic and telluric agencies, all as yet singularly averse to organic life, were at work. While, however, there are no apparent signs of mechanical disturbance during the long period that elapsed from the cooling of the earth's surface to the deposition of the Silurian and Cambrian systems, it is to be presumed that the internal igneous activity of the earth's crust was in full force, so that on the inner side of it, in obedience to the laws of specific gravity, chemical attraction and centrifugal force, a great segregation of silica in a molten state took place.[14] This molten silica continually accumulating, spreading and pressing against the horizontal Cambro-Silurian beds during a long period, at length forced its way through the superincumbent strata in all directions; and it is abundantly evident, under the conditions of this force and the resistance offered to its action, that the line it would and must choose would be along any continuous and slightly inclined diagonal,[15] at times crossing the strata of the schists, though generally preferring to develop itself and egress between the cleavage planes and dividing seams of the different schistose beds. Thus were formed in a more or less horizontal position, in all directions, innumerable flakes and extensive sheets of quartz rock, apparently interstratifications as regards their strike, but only apparently such, for they distinctly traverse[16]

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[14] At that time, when the atmosphere was pregnant with many different substances of a dense nature and higher degree of temperature, both of which would, to a certain degree, explain the scarcity and low scale of organic life, it is to be inferred that the incandescent state of the earth's nucleus was capable of enormous igneous action. Professor Ansted says on this subject—"the Huttonian hypothesis, that the contents of veins were in all cases injected from below in a state of igneous fusion, is scarcely more probable or better founded than the rival theory of the Saxon geologist. That some indeed of the cracks in the strata, such as trap dykes, have been so injected must be regarded as probable, because in many cases we actually see the effects of heat on the rocks forming the walls of the dyke, and it is clear that quartz and many other minerals, and probably also metalliferous ores may have been forced up from below." And Professor Cotta remarks —"it does not seem absurd to admit that, in some cases, quartz lodes were the result of a single igneous injection of molten silica which had been segregated by chemical action." Besides this, subsequent igneous rocks (granite for instance) prove that the quartz they contain must have been in a molten state, because it is crystallized.

[15] The normal line would be that of the greatest resistance.

[16] Fulfilling therein the conditions which constitute a lode; in fact, the

and intersect the underlay of the slate rocks, being thicker between the schistose planes, and narrower when intersecting them. From the quartz rock started quartz veins, some (β) running almost parallel with, and others (γ) perpendicular to its position, while other veins (δ) shot out in capricious planes and directions. These veins or leaders, all thin, and run out in comparatively short distances, especially such veins as cut across the slates at the line of the greatest resistance. Simultaneously with the upheaval by the granitic rocks of the Cambro-Silurian slates in average meridional line the approximately horizontal main quartz belts were upheaved and placed on edge along with the schist strata by this general disturbance. It is in consequence of this change that the quartz belts are apparently interstratified, while in reality, they are merely intersecting. The positions having been altered, what formerly was or approached the horizontal, became perpendicular and *vice versâ,* so that horizontal sheets of quartz reefs which had been forced between the schistose cleavages and different strata, appeared as almost perpendicular quartz lodes,[17] their strike being conformable to the general meridional bearing of the schist, and the coincident line of upheaval, their underlay intersecting that of the slates to the East or to the West, the veins (β) which ran parallel, following the main course of the quartz rock, the perpendicular veins (γ) becoming horizontal or flat, while the other veins (δ) would take their respective analogous positions. In the same manner the horizontal sheets of quartz rock, when upheaved in the medial line of action, would show along their approximate meridional line a varying shoot to the north or to the south ; a north-east or north-west horizontal development of quartz rock would thus necessarily, when upheaved, have its shoot northerly,[18] while a south-east or south-west stretch would present a southerly[19]

expression "a horizontal lode" does not seem to be an inappropriate phrase. Cotta (page 78) says—"a lode, therefore, can be in an horizontal position." Sir R Murchison, however, has lately objected to the expression in his reply to Mr. Zachariæ's letter.

[17] It is to be remarked that the miners of Bendigo and other parts of the colony call quartz lodes only such quartz dykes as are checked with slate and sandstone, irrespective of their position.

[18] Almost all quartz lodes on Bendigo have a northern shoot.

[19] At Ballaarat most of the quartz lodes have a southern shoot. From this it would seem that one great focus of eruption was situated between

shoot, and a lateral upheaval would, of course, reverse the above order. In quartz lodes where there is no noticeable or well defined shoot in either direction, it may be inferred that their original development was indifferently either north, south, east, or west; and this is precisely the appearance which auriferous quartz lodes present in nature to the miner and the geologist; they form innumerable more or less perpendicular quartz dykes and extensive quartz rock belts which strike, but with few exceptions, in an approximate meridional line, thus disclosing to view, on a gigantic scale, that remarkable parallelism which, after all, is but a natural feature necessarily consequent on the almost unvarying strike above alluded to. These auriferous quartz lodes intersect the strata of the slate rocks, and are cased with walls of slate and sandstone; they have quartz veins issuing from them in various directions across the country as leaders, flat veins, &c. They sometimes form themselves into irregular masses of veins, at other times they appear as massive bodies of quartz rock which dwindle into strings that serve as the connecting links with some other quartz blocks. These facts go to show that the quartz lodes when forcing their egress often disturbed, fissured, and rent the enclosing schists, the openings so effected being instantly filled by the quartz stone, thus giving rise to those capricious irregular or zigzag shapes vulgarly termed east and west veins, &c., which are frequently met with in underground workings. But there are other than the cosmic and geological conditions mentioned which prevailed at the time of the origin of quartz lodes, and they also equally indicate the plutonic character of this dyke formation. Under this head is to be reckoned the occurrence of felspar[20] in quartz veins, for it is an established scientific fact that mica, felspar, and amphibole or augite, are all minerals none of which can be formed apart from

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Yandoit and Slaty Creek, near Creswick. In some cases the shoot of the lodes in connection with the lateral upheaval would indicate the original direction of the development of the lodes. This theory, if closely followed up, might divulge most interesting and conclusive facts, which as yet, but in embryo, are not worth stating.

[20] In the Cosmopolitan claim, Golden Point lead, Ballaarat, a quartz lode has been struck at a depth of 347 feet, which contains crystals of orthoklas. Mr. Ulrich found a felspathic mineral in the gangue of the Whip Reef Bendigo. (*Col. M. Jour.*, May 1859, page 137.)

igneo-chemical action.[21] This single fact would alone go far to indicate the originally molten state of the silica of quartz lodes.[22] Another argument to the same end may be drawn from the fact that the auriferous quartz lodes have exercised a manifest metamorphic action on the adjacent walls or casing; they have done so partly in a mineralogical sense, but generally there has been a metamorphic alteration of the rock. Hence it is that in the immediate contact of the quartz lodes the schist or fragments of it are generally more or less micaceous or altered into their laminæ of mica, crystalline laminæ of nacrit or of chlorite[23] which has invariably tinged the adjoining quartz with a green color. Among these minerals is one at times disintegrated[24] which shows the cleavage of orthoklas. There are but few minerals found at the contact of the schist and quartz rocks. This, however, is only natural, for the interchanging rocks were of simple chemical composition.[25] The metamorphic influence exercised by

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[21] On this subject the dissertations of G. Rose are highly interesting, as are also the experiments of Hall, and the chemical experiments of Mitscherlich and Berthier, who were successful in counterfeiting, by igneo-chemical action, augite, olivin, and magnetic iron ore. It is a remarkable fact that distinct felspar crystals were found in a copper furnace at Sangerhausen. (*Cotta*, page 372.) Six-sided prismatic crystals were found in the slags of a copper furnace at Gorpenberg. (*W. Phillips' Mineralogy*, page 390.)

[22] The fact of felspar not having been oftener observed in quartz lodes is due to two causes; in all probability, down to some depth felspar is likely to have been disintegrated into porcelain clay and into soluble silicate of potash, the latter having been washed away, and the former having remained in the cavities, in a state of Kaolin, in which it is almost undistinguishable from decomposed slate, vulgarly termed "pipe clay," even by those who make some pretension of knowledge in the matter, and totally so to those who are unacquainted with the character of the mineral. The Old Post Office Hill Reef, Ballaarat, has furnished quartz bearing impressions with the apparently crystallographic angle of orthoklas, but the fact stated in note 20 is the clearest evidence obtainable.

[23] Not green earth.

[24] Near the Brown Hill, at the junction of the Fellmonger's and Gong Gong Creeks, there is a quartz lode which contains among the chlorite a somewhat disintegrated mineral, which has the cleavage of orthoklas.

[25] The elements acting on each other were chiefly silica, alumina, magnesia, and alkalies; consequently the minerals found at the contact of the quartz and schist are the result of the several combinations of these elements: therefore none of the more complicated silicates, such as pyroxene, diallage, amphibole, epidote, garnet, &c., have been found.

the quartz rocks on the bordering strata is very striking, though it is not easy to distinguish it all over them, it is preeminent in the mining district of Tarrangower, where all the quartz lodes are separately cheeked and walled by distinct accompanying strata of dark silicious schist[26] or Lydian stone, evidently slate and sandstone schists hardened by the metamorphic action of the quartz lodes,[27] in the same manner as when acted on by igneous or volcanic rocks, apparently changing the physical conditions without altering the chemical quantities. This metamorphic action is observable in the Tarrangower district for many miles. In the Bendigo district the metamorphic action is also to be seen,[28] quartz rock belts being often carried in between hard ferruginous schists which, however, are generally disintegrated, and do not therefore present any very prominent metamorphic features. In the Ballaarat district the metamorphic action of the quartz lodes may also be detected, although the rocks there are even more disintegrated[29]

[26] This silicious slate is brownish black, solid, very hard, rings when struck, has a fine splintery fracture, and splits in rectangular planes ; it might be usefully employed in underground masonry.

[27] A similar metamorphic action is observable south of Buninyong, on the north-west slope of a basalt cône, at Green Hills, where the basaltic rock, breaking through the schist, entangled huge flakes of the latter, which are partially, and in many instances entirely, transformed into flinty slate by the metamorphic action of the basalt.

[28] As already stated, it is only in the Bendigo district that graptolites have been found, and then principally in beds of roofing slate, though occasionally in the slate contiguous to a quartz lode, as at Paddy's Reef. It has been observed by several persons, who have given this subject their attention, that the igneous origin of the quartz lodes would have necessarily destroyed all such fossil remains. This may be true to a certain extent but the objection is more apparent than real ; for where the strata have been only partially exposed to metamorphic action under great pressure, atmospheric agencies being excluded, or where they have not been exposed at all, or even where they have been wholly exposed—combustion being absent—there is no sufficient cause shown calling for the admission that all the impressions of organic remains would be totally destroyed or obliterated. The organic substance may have been changed, or removed and then replaced by other matter, which, adapting itself to the impressions, would thus conserve them. It is in this way that the impressions of graptolites are generally found, the original organic substance having been removed, was replaced by a ferruginous, glittering, delicately laminated representative.

[29] It has been stated by several persons "that the present soft state of the schist rocks through which the quartz lodes pass is a clear proof that the quartz rock did not force its egress in a molten state." This opinion

than at Bendigo; it is not very easy, therefore, to distinguish their mineralogical composition with any tolerable degree of accu-

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totally ignores the softening, crumbling, and washing power of disintegration which has been incessantly at work during many geological ages, else it would not be looked for that the metamorphic schists should have conserved their original appearance; the siliceous schists of Tarrangower might possibly have done so, but in the case of the more argillaceous schists of Bendigo, Ballaarat, and other localities, it was not to be expected. It has also been adduced as an argument against the igneous theory that if it were true the quartz lodes should be sometimes found protruding as conical shaped hills, as in the case of basalt, and that the direction of the currents might be traced. It has also been said for the same purpose that a similar appearance ought to be seen on the slates in contact with quartz lodes, as is manifested when they are burned in a kiln. To the latter objection it need only be answered that in the one case the metallurgic process is conducted in the open air, while the metamorphic action took place under totally different circumstances, such as the exclusion of air, &c., so that, as might naturally be expected, the results are greatly different. To the former objection the reply would be that the ancient igneous rocks rent the earth's crust in longitudinal extension, and thus formed mountain chains which were subsequently crossed by other igneous rocks and dykes. Gradually the bases of these mountain chain nuclei, and the earth's crust generally offered greater resistance to the protrusion of later igneous or volcanic rocks, which, being of less volume than their predecessors, made their way, as is generally the case, along the old but confined eruptive outlets, and therefore did not do so in long cracks or rents, but through funnel canal-like passages or craters, which is the invariable condition of volcanic rocks forming round-topped hills. But, even admitting that the quartz had originally formed round-topped hills, the enormous abrasion which the schistose formation, including the quartz lodes, is seen to have undergone, would have obliterated every vestige of conical shape. According to the theory stated here it would be remarkable indeed if round-topped hills had been formed, since it was laid down that the quartz lodes were injected in horizontal beds. The objection urged above would be valueless even had the protrusion of the quartz lodes been subsequent to the upheaval of the Silurian system, because the protrusion of plutonic rocks in longitudinal crevices, not only in most instances removes the idea of round-topped hills, but even of an overflow remotely calculated to cause such shapes. But, in reality, the objection of round-topped hills militates as much against the aqueous as against the igneous theory, for the former is based on the supposition that its agent was in such gigantic force and volume as must have caused the overflow in most instances to assume almost the shape which an igneous overflow would take. And after all, why should these peculiarly shaped hills be looked for in connection with quartz more than with the quartz porphyry of Thureau, at Maryborough, or the volcanic dykes of Bendigo?

racy. The hard, compact, partially disintegrated strata of Ballaarat which separate the quartz belts from each other, may be considered to correspond geologically with the metamorphic silicious slate of Tarrangower. The same metamorphic action can be traced throughout the districts of Amherst, Avoca, Creswick, &c. Another reason for the igneous origin of the auriferous quartz lodes consists in the mechanical disturbance caused by the protrusion of the quartz lodes themselves. It is to be constantly observed that the strata of the schistose rocks are more or less contorted—that their underlay is variable to the east or to the west—that fragments of them are entangled in and metamorphosed[30] by the quartz lodes, and that in consequence the adjacent country, to use a mining expression, is frequently broken up into fragments, forming a breccie[31] of commingled slate and sandstone, whilst the quartz lodes and veins traverse the same country intact and unbroken. The inevitable inference is that the disturbance was caused by the forcible protrusion of the quartz lodes. From the above facts and deductions, it can therefore be maintained that the gangue of the auriferous quartz lodes is of igneous origin, and not the result of the gradual deposition of quartz from a silicious solution. In addition to the positive arguments already adduced, which base themselves on geological observations, there are also negative ones, the result of scientific deductions, which lead to the same conclusion. Starting from the established fact that silica is dissoluble in water and water vapor, during its separation from alkalies,[32] the first considerations which present themselves are

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[30] Nuggety Gully, Tarrangower.

[31] This circumstance is to be observed at Bird's Reef, near Kangaroo Flat, Bendigo, where the broken up and mixed angular fragments of slate and sandstone are jumbled together and form a breccie several yards in thickness, which is traversed by perfectly well-defined and connected quartz veins.

[32] Leibeg says, "in the form in which silica is separated from a soluble silicate in boiling water by the addition of an acid, a compound of silicate with water, termed hydrate of silica, is precipitated, which possesses a certain degree of solubility in pure water; indeed, when sufficient water is present during its separation from a base, the whole remains dissolved;" and again, he says, "Forchhammer has shown that felspar may be decomposed by water of 150° C. (302° F.), and that at a pressure corresponding to this temperature the water becomes strongly alkaline and is found to contain silica in solution The hot springs in Iceland possess a

in reference to the supply of the great quantity of alkaline silicates, which at that time could only be of a felspathic nature. How under the then existing circumstances could the enormous quantities of water or water vapors, requisite to dissolve the immense mass of quartz which was to form the innumerable quartz lodes now existing, continuously find their way into the bowels of the earth? The number of these quartz lodes could hardly be attributed to aqueous agency, as a solution contains no intrinsic forcing power, and could therefore have but comparatively few outlets. More than this, the felspathic rocks having been deprived of their alkaline silicates to form silica, there would remain an immense bulk of clay, and the disposal of this residuary mass is not accounted for in any way. It is another weighty consideration also, that the formation of quartz lodes by the deposition of silica, from an aqueous solution, would necessarily involve the production of hydrous silicates, zeolithes, hyalite, opal, &c., which are always present in the deposits made by silicious thermal springs, as in the geysers in Iceland, and indeed in all volcanic eruptions in which there were aqueous vapors, it is so in basalt, &c. These are all minerals which authenticate the presence of water vapors at the time of their formation, and are to be found in the gangue of many metalliferous lodes, as at Andreasberg, Stronsian in Scotland, Ciclowa near Oravitza, in the Banat, Huelgoet in Brittany, Konsberg in Norway, &c.[33] The quartz lodes of this country show a character quite distinct from that just now referred to; for nowhere are the hydrous silicates, or the other minerals named, to be detected in them; and it is therefore to be inferred, that their non-existence demonstrates the impossibility of the origin of quartz lodes being due to an aqueous solution.[34]

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high temperature, and come from a great depth, where they must have been subjected to a high pressure. He has also shown by analysis that the water of these springs contains the constituents of soda, felspars, and magnesian silicates, minerals of very frequent occurrence in trap districts. There cannot be a doubt that a conversion of crystalline felspar into clay must be proceeding to a great extent at the bottom of these springs."

[33] The formation of these minerals zeolithes the disposition of thermal springs in the lodes quoted, took place most probably at a posterior reopening of the interstices of the lodes about the epoch which would correspond to the melaphyr age.

[34] The hollow stair-fashioned shape so often met with in crystallized gold is a suggestive proof of its contraction whilst congealing, a character

The next question is as to the metalliferous character of the quartz lodes. There are but few metals or metallic minerals to be found in them, and they are gold,[35] iron,[36] and arsenical pyrites,[37] the last two in some instances in great quantities; copper pyrites, zincblende, galena, molybdenite,[38] pharmacosidorite,[39] hematite[40] or glaskopf, and malachite;[41] the last three, however, are oxygenated, and are therefore to be looked on only as minerals of secondary formation, the result of the disintegration [42] of the primitive minerals, which are arseniurets and

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assumed also by other metals, as bismuth, &c., when congealing; this shape is therefore evidence of its previous molten state, thus tacitly indicating the original igneous state of the silica in quartz lodes. An objection raised by Mr. Selwyn against the igneous theory is to be found in the *Col. M. Jour.*, p. 90, where he says, "that in all quartz reefs on every gold-field in the colony, the auriferous formation contained silurian fossils, the most delicate and beautiful organic remains, shell-fish, &c., in the most perfect state of preservation." This statement is somewhat indefinite. Is it to be understood from this that the gangue of all quartz lodes in the colony contains silurian fossils; or only that the auriferous formation (by which the Cambro-Silurian system is probably meant) contains the above-mentioned organic remains? If the latter, such would not militate against the igneous theory of the quartz lodes; and if the former, it is difficult to reconcile in one and the same gangue the presence of fossil remains and felspar.

[35] The gold is very pure; it is often to be found crystallized, mostly in dodecahedrons, hexahedrons, or the combination of hex and octahedron or hex-octa-dodecahedron. The writer has seen a remarkably fine specimen of alluvial (Ballaarat) gold, it was a group of inch and half-inch crystals of the hexaoctahedron crystallographic form, hollowing towards the centre of the faces stair fashion, parallel to the combination lines. It contained very little quartz, and weighed 9½ ounces. Dr. Hochstetter was desirous of purchasing it as a, perhaps, unique specimen; other specimens of the same crystallographic form, but smaller, are occasionally found.

[36] In many reefs, as the Cornish United, Gum Tree Flat, Ballaarat.

[37] Whip Reef, Bendigo, and German Reef, Tarrangower.

[38] A beautiful specimen of this mineral is in the possession of the writer, having been given to him by a miner of Wattle Gully Reef, Tarrangower, who stated that he had found it in a quartz lode in that vicinity.

[39] Bendigo.

[40] In every quartz lode.

[41] Maryborough, Bet-bet Reef, Steiglitz, and other localities.

[42] The crystals of iron, as well as those of arsenical pyrites, contained in the walls and gangue, are transformed, when near the surface, into pseudomorphous crystals of hematite, and they are sometimes so deteriorated that their former existence can only be known by a ferruginous

sulphurets. These minerals ascended simultaneously with the quartz; and the contemporaneous formation of the quartz gangue, the arseniurets and sulphurets implies the forcing up of these minerals in a sublimated state. The heat of the molten silica would necessarily volatilize the gold as a vapor of purple color,[43] and would also sublimate the arseniurets and sulphurets, which are all volatilizible without being decomposed, at a much less temperature than gold, the air being excluded.[44] They are found decomposed only near the surface. Thus the purple fumes of metallic gold and sublimated vapors of the arseniurets and sulphurets of other metals, entering the quartz gangue, permeated it as gaseous vapors, forming veins, shoots, and streaks, interlacing the gangue in the direction of its stretch, penetrating also into the recesses of the quartz veins and leaders, the gold being precipitated in gold-leaves, film, &c., on comparatively cold bodies, such as the sides of the lodes, or entangled pieces of schist,[45] and accompanied by the sulphurets and arseniurets. The sulphurets, arseniurets, and other volatile metals, influenced the

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stain, or by the corresponding form of the empty impressions. The quartz joints and the sides of the lode have often been covered by a crust of hematite. sometimes only by a peacock-colored film. The disintegration of large masses of iron or arsenical pyrites along the sides of the quartz lode would give it the appearance of the Eagle-hawk Reef, Tarrangower, where there is a layer of hematite a foot thick on the underlay of the lode. This hematite, in some instances, yields between four and five ounces to the ton.

[43] "Gold cannot be volatilized even when heated to white heat, according to Kunkel, who kept gold in that heat for forty days; but it can be so in the hydro-oxygen flame, in the focus of powerful lenses, and in the current of a powerful galvanic battery, as a purple-colored smoke which covers cold bodies with an auriferous film."—(Werhle's Metal., vol. 2, p. 518). Daniell says, "gold melts at a temperature of 2016° F., and when still more intensely heated it affords perceptible fumes. A globule of gold exposed between two charcoal points to the action of a powerful galvanic battery gives off abundant vapours, by the escape of which its weight is rapidly diminished."

[44] This is a conclusive proof that such was the case; that is, that during the protrusion of the quartz lodes, air was excluded, since the arseniurets and sulphurets are only to be found decomposed, that is, oxygenated in the upper levels of the quartz lodes down to where atmospheric agencies could penetrate.

[45] This is the case to a very marked degree at Nuggety Reef, Tarrangower, and indeed almost invariably in most quartz lodes.

volatilization of gold, and in this way it was carried into and lodged in the crevices, joints, and sides of the lodes, where it could not have reached [46] unless accompanied by the sulphurets and arseniurets. Hence we find gold in its metallic state mixed mechanically with iron [47] and arsenical [48] pyrites; sometimes, it is even perceptible to the naked eye, at other times it is not; and it is also found mixed with galena [49] and zincblende. [50] Indeed it is scarcely possible to find either of these two minerals without at the same time finding gold in contact with them. Of the minerals enumerated, iron and arsenical pyrites are found in large quantities in the quartz gangue; but copper pyrites, galena, and zincblende, are seldom found, and then in insignificant quantities. It is to be remarked that the affinity of these different minerals is according to the following scale—first, galena, then, and almost if not quite equally, zincblende, arsenical pyrites come next, and iron pyrites follow; and therefore gold is contained in the gangue along the shoot of these metalliferous ores; but where the gangue is far apart from the metalliferous indications, it is generally barren. [51] On this theory it is not difficult to account for the flat leaders and the running out of the quartz stretches, now the caps of the reefs, being often richer than the rest of the gangue, or to account for the poverty or richness of reefs, when they suddenly [52] become contracted for a certain length, conformable to the greater or less opportunity offered to the gold to precipitate according to the physical circumstances, such as mechanical impediments, change of temperature, &c. It has been attempted to explain the origin of gold as being the result of precipitation by iron from its solution,[53] under the influence of

[46] "Gold is to be volatilized at a comparatively low temperature when in connection with antimony, arsenic, and other volatilizable metals."—(Werhle.)

[47] Red Hill and Gum Tree Flat Reefs, Ballaarat.

[48] German Reef, Tarrangower, and Whip Reef, Bendigo.

[49] Nuggety Reef, Tarrangower, and in many reefs of Bendigo, &c.

[50] Mount Egerton, &c., &c.

[51] The presence of these disintegrated minerals is of course of the same importance as metalliferous indications.

[52] These observations, if critically followed up, would perhaps be the means of saving much capital and labor in mining pursuits, and of defining the course of quartz mining by empirical rules.

[53] Mr. Burrowes says, "iron has decomposed the solution of gold which has been deposited slowly and crystallized, perhaps, under the influence of an electric current." See also Mr. Hulkes, *Col. M. Jour.*, page 152.

electricity. Without entering into the chemical part of this theory, it may be sufficient to remark that the theory in question is one-sided, only accounting for the formation of gold, but not of the sulphurets which would be decomposed.[54] Strictly, then, the simultaneous deposition of gold, sulphurets, and arseniurets, goes to prove chiefly that a very feeble electrical agency was at work in the formation of the quartz lodes. However, it was owing to the subsequent electrical influence, at first an electro-chemical one evolved by the disintegration of the primitive minerals, that even remote substances were decomposed, and that new combinations were formed—the secondary minerals, such as cube ore, pseudomorphous hematite, &c.; their elements being transferred by electrical currents even through moist non-conducting solids, and in some cases during the process they were deprived of their chemical properties,[55] or in other ways influenced by electric agency. It is to the action of these currents of electricity, whose intrication Mr. Fox[56] has so well described, that the present partially, or entirely, disintegrated state of the upper levels of the quartz lodes is chiefly to be attributed. From the igneous origin of auriferous quartz lodes and metallic ores it would be correctly inferred that the gangue would exhibit a homogenous character; this, however, is not always the case, although it is so generally. Where it is not so, it is no doubt due to the subsequent re-opening of the gangue fissures, more recent protusions of quartz rock having almost disconnected[57] the more ancient veins, or else

[54] Mr. F. Manduit says, "how shall we account then for the presence of the sulphurets of copper, lead, &c.; for a galvanic battery decomposes compounds of metals, salts, &c.; but I have not read of such compounds being formed by such agency."—*Col. M. Jour.*, p. 122.

[55] Davy's experiments repeated and confirmed by Becquerel.—*Lardner*, p. 245.

[56] Mr. Fox says, "electrical currents thus circumstanced would deposit the bases of the decomposed earthy and metallic salts on different parts of the rocky boundary of the vein, according to the momentary electrical state and intensity of the different points; and the nature and position of the rocks would be influential in determining these conditions. When by such processes particular arrangements had happened new actions might arise, and amongst them a series of secondary phenomena such as the transformation of ores without change of form, a fact otherwise very difficult to comprehend."

[57] Panton, *Col. M. Jour.*, p. 88.

formed a new body in their midst, and so giving to the whole, for some distance, a flaky, laminated, or seamy appearance, which is greatly increased by entangled schistose fragments and veins of metallic substances, either decomposed or otherwise. But that order of deposition of different substances, corresponding with the faithful parallelism from the sides of the lode towards its centre, cannot be found, though it is a remarkable feature in many veins containing carbonates of lime, iron, &c. Werner first called attention to this striking arrangement, of which Weissenbach has given numerous examples, and which was evidently caused by the agency of water. Thence it is that the seamy appearance in some portion of the quartz lodes does not point to the conclusion of an aqueous origin, for it is irregular, however apparently otherwise at first sight, as it does not fulfil the above described conditions of parallelism. In some districts the quartz lodes have been disturbed by felspathic or igneous rocks, forming dykes of a more recent epoch. Hitherto the felspathic dykes of Bendigo and Maryborough have received the most attention; in the former district they are found at times traversing[58] the quartz lodes, following their strike, or faulting them; and in other cases, separating their course from them, they crop out on the surface. They are greatly disintegrated,[59] so much so, that it is not possible at present to give their mineralogical composition with accuracy, or to determine their geological age beyond what has been already advanced. They do not seem to contain zeolithes, but they seem to be intimately connected with the subsequent changes[60] in quartz lodes, such as the re-opening of the quartz veins, and also

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[58] Phillips's Reef, Bendigo.

[59] At Bendigo these felspathic dykes are called "pipeclay," "lava," or "slide" veins. This rock is frequently disintegrated into greyish yellow clay, in which no remains of its previous mineralogical composition are to be detected, as at Bird and Balderstedt's Reefs, Bendigo. At Phillips's Reef it has a crumbled earthy appearance and a dark green hue, in which greyish white specks of kaolin and green earth respectively betray the felspathic composition of the rock, and suggest the idea as to its amphibole or pyroxene character. At the Glasgow Reef this rock is even less decomposed; it is clayey, of a greenish color, containing a filamentous mineral, also decomposed, of a dark green color, amphibole or pyroxene.

[60] At the Whip Reef, Bendigo, the quartz lode, which crops out four feet in thickness, is represented by these mineral lodes of auriferous arsenical pyrites.

the occurrence of large masses of arsenical pyrites, which, and it is a most interesting fact, as it shows the connection of this metalliferous ore with heat, contain a felspathic mineral [61] as already stated. In the latter district they have been called quartz porphyry,[62] and seem to be of precisely the same character as those of Bendigo; they disturb and are connected with the quartz lodes in a similar manner, and are in a state of partial disintegration; their mineralogical character may be somewhat different, as their name—quartz porphyry—indicates. It is, nevertheless, probable that both these igneous rocks are contemporaneous. At Ballaarat no igneous dykes have been yet observed, either on the surface or underground; thus disturbances as "faults" are of rare occurrence; up to the present time none of any consequence have been found, and it is a remarkable fact, also, that arsenical pyrites have not been found there, either in small or large quantities, as at Bendigo, Tarrangower, &c. In the sandstone walls[63] of a very few quartz lodes the empty impressions of arseniuret of iron have been found. Would the absence of igneous dykes not seem to pre-suppose that the quartz lodes have not been re-opened, and that, therefore, arseniurated masses of auriferous character could not have been injected? And might not the comparative poverty of the Ballaarat quartz lodes be also thence presumed? From what has been stated as to the theory of the igneous origin of auriferous quartz lodes, it may be logically deduced that the presence of sulphurets and arseniurets in a quartz lode is an empirical test of its comparative auriferous character; that the appearance of igneous dykes in connection with quartz lodes, and contemporaneous with those mentioned, would give a more auriferous stamp to any district; and that auriferous quartz lodes are to be expected, intersecting the schistose formation, at

[61] See note 20.

[62] Mr. Thureau says of the Maryborough district, that "dykes of quartz porphyry are found to exist of undoubtedly more recent formation than the quartz lodes which have produced 'faults.' There certainly exists a great difference between the different species of quartz porphyry, from the green and hard porphyry, which encloses beautiful crystals of felspar, down to the friable whitish species."—*Col. M. Jour.*, June, 1859. This description is very similar to that given in the text. The different appearances of the quartz porphyry is most likely to be attributed, as in Bendigo, to the different stages of disintegration.

[63] Prince Albert and Old Canadian Hill Reefs, Ballaarat.

any depth. The last statement is borne out by the following considerations: first, it can be easily imagined, if the enormous abrasion be taken into account, how deep the present surface with its yet auriferous quartz lodes, must have been under that which existed before abrasion took place; again, the granite which simultaneously upheaved the Cambro-Silurian and auriferous quartz rocks, disturbed the thick schistose formation with such gigantic force that it contorted and placed the beds on edge, thereby causing enormous convulsions and faults, on a scale too grand to be noticed by the miner; and it is evident that in some instances strata of the schistose and quartzose formation which, before the upheaval of the granite, were far below the formerly existing surface have been disclosed[64] by that upheaval, and that these strata contain quartz lodes in no wise less auriferous. It may, therefore, be maintained that to as great a depth as the quartz miner can ever penetrate, he will find auriferous quartz lodes, and that deeper still there are others equally auriferous.

The search for auriferous quartz lodes and the raising of "stone" from them should be carried on according to the rules of systematic mining which have been adopted as applicable to the working of such metalliferous lodes as present the same general features. Auriferous quartz lodes are generally found cropping out at the head of gullies which flow from schistose ranges, and which contain an auriferous diluvial or alluvial deposit. In many instances the prospecting of such quartz lodes will require a longer time and the expenditure of more capital than might at first be supposed necessary, for frequently, even where the lode has been struck at different levels, the metalliferous shoots have not been reached. In these cases the further prospecting operations, such as putting in drives along the course of the lode and at different levels, so as to cross the adjacent or remote auriferous shoots, must be guided entirely by the metalliferous indications of each separate mine. Properly conducted prospecting operations should not only serve to discover the auriferous quartz, but to become preparatory works for the further development of the mine. In this way proper ventilation may be effected, drainage secured, winzes cut, and pitches got ready in connection

[64] The auriferous quartz lodes of the Tarrangower district to the west of the sinclinal line, towards the Mount for instance.

with the former workings, while the other mechanical appliances are being got in readiness, so that the further operations of the mine and the raising of stone may be carried on at different levels. The mine will thus be capable of producing a continuous and certain supply of stone, under a system which combines economy to the proprietary, safety to the miners, and the general good order of the present and future operations of the mine. The ordinary working operations for the removal of the stone should be carried on, in most cases, as they are generally performed in other metalliferous lodes; but in cases where the quartz lode is a mass of from 30 to 40 or 100 feet thick, resembling stock works, and it is desirable to remove the entire body, it would be advisable to run a deep level along one side of the lode and another several fathoms nearer the surface, then to join these levels by winzes. The removal of the lode should then be commenced between the levels, at the further extremity of the quartz mass, working backwards toward the shaft; then again putting in a level several fathoms higher, and working in the same way level after level, the whole of the stone could be raised economically; the portion of the lode removed being replaced by rubble introduced into the mine from the surface, and thrown into the working level through the winzes.[65] Mining operations have shown that the quartz lodes are subject to disturbances, which disconnect them, and so give rise to "faults," which of course affect the regularity of the under ground works where they occur. The mining experience of this country seems to indicate that the underlay strata of the "faulter" are those which have been disturbed,[66] and "the probable direction of the movement which caused the displacement may be detected by an inspection of both grooves," and also that "generally the lost lode has been found by simply following the faulter."[67]

In this colony the stone, when raised, should be classified into "quartz stone," and "quartz stone containing pyrites," to facilitate the extraction of gold from these matrices, inasmuch as they necessarily require different manipulations. The extraction of gold·

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[65] This method has been successfully employed in the working of the thick and highly inclined coal-seams at St. Etienne, near Lyons.

[66] Thureau, *Col. M. Jour.*, cuts III. and IV., June, 1859.

[67] *Col. M. Jour*, June, 1859. The careful study of such disturbances would save a certain amount of capital, and in some instances would recover valuable mines.

from quartz "stone" is simple compared with the ore dressing and metallurgic processes necessary for the extraction of other metals; it is effected by burning the stone, reducing it by stampers or otherwise, and then concentrating by washing and amalgamating. The burning of the stone is most conveniently effected in large kilns, high, brick-built erections, in which continuous action can be carried on, the stone being charged or placed in them at the top, along with the requisite fuel, and then scraped or allowed to fall out below, over the inclined double bottom of the kiln. Furnaces are placed on the other opposite sides of the kiln so that the required heat may be kept up and regulated during the process.[68] The practice of burning stone in this manner might be introduced with advantage in this country, and indeed ought to be so in all cases where the necessary fuel is easily and cheaply procurable. Among the advantages which would follow from the adoption of this practice more generally are, first, that a greater quantity of stone might be comminuted in the same working time, the increase ranging as high as 30 per cent. Again, the wear and tear of the reducing machinery, of whatever sort it might be, would be considerably less; and, still further, a greater proportion of the contained gold would be obtained,[69] in some cases as much as 15 per cent. additional. There is another argument beyond those of profit to the owners of the mine, which shows the advisability of burning quartz: the argument is one which suggests itself when viewing the question from a polito-economical point of view, and is worthy of consideration, inasmuch as it can be put in practice to the improvement of the community without causing

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[68] Some stone contains a small proportion of pyrites, iron and arsenical, and gold may be volatilized along with the sulphur and arsenic—principally with the latter—fumes. The writer, when burning such stone—gas coke being used as fuel—was obliged to shut the top of the furnace with a moveable iron disk, and conduct the fumes into a condensing chamber. Before this had been done the rim on and around the top of the furnace, down to several inches, had been covered with a filmy, peach-colored, velvety coating, which, on being tested, proved to contain gold.

[69] The writer found in a carefully conducted experiment, that of 200 tons of quartz, separated as third-class by picking, the largest pieces being about 30 cubic inches, 100 tons, without burning, when crushed and concentrated gave for twenty days' work, and £106 8s. expense, the sum of £116, while the other 100 tons, after burning, crushing and concentration gave for fourteen days' work, and £79 12s. expense, the sum of £135.

loss or detriment to the mining capitalist; it is this, that the profits accruing from the burning of quartz over those from the using of it as it leaves the mine, would at least cover all the outlay incurred by the employment of extra working hands in the process of burning. The trituration of the stone is generally effected by stamping mills, because of the large amount of "stuff" they comminute in a given time. The Chilian mills, with rollers, are preferable where the quartz requires to be ground very fine, as, when it is highly auriferous, or when the gold is of a very fine description, the process requires great care and sufficient time, therefore from 11 to 12 revolutions per minute is a proper speed. Without altering the conditions, the effect of these mills would be enhanced by having three mullers, or four instead of only two. Stamps, however, have of late attained such a degree of perfection, and are in all respects so well adapted to perform the trituration required by the general class of stone found in the mines, that in a practical point of view they are the most efficient reducing mechanical appliance. There are several conditions and contrivances which are necessary to ensure the efficient duty and good working, mechanically speaking, of stamping mills. First of all comes the weight of the lifters, their pitch, the number of blows they give per minute, and the quantity of water used in stamping. They are good proportions which are adopted at that model establishment the Port Phillip Company's works at Clunes.[70] Among other efficient contrivances are linings of metal inside the cast-iron "cofers," iron lifters working to save wear and tear and friction, in hardwood block-guides, &c. A prominent one is the use of the so-termed "false bottoms" which not only save the deterioration of the bottom of the "cofer," but also, and that is the great value which is to be attached to them, prevent the gold from being "stamped dead,"[71] or, in other words, "from being brought down to such an infinitesimal size that it floats away

[70] Mr. Thompson has communicated the following data as the conditions arrived at by practical experience, at the P. P. M. Co.'s works, Clunes, where part of the quartz is burned :—Average stamp weight, 5 cwt.; pitch, 8 to 9 inches; from 76 to 80 blows per minute; and from 4½ to 5½ gallons of water per minute to each stamper.

[71] Mr. Warrington W. Smyth makes use of this expression and others as "wild flood," "schlich," &c., which are of German origin. Lect. on gold, page 102.

with water." The concentration of the gold from the liquid slime or stamped "stuff" is effected in very different ways: at Schemnitz, in Hungary, it runs over inclined boards covered with canvas,[72] and in other places, as at the Port Phillip Company's works, Clunes, blankets are used; or, as in South America, hides are substituted for these canvas-lined boards; but all these contrivances have the disadvantage that they do not save the gold if they are not constantly attended to and changed, for the slime settles and forms a coating over which the gold passes without hindrance. When the gold is thus saved it is further dealt with by washing and amalgamation. Instead of all these contrivances the concentration may be effected almost equally as well, by long riffle boards, the riffles being so constructed as to cause a bubbling motion in the slimy current passing over them, the boards having an inclination just sufficient to keep them clean; they should be cleaned out three or more times in the twenty-four hours. The stuff running from the tail end of the riffle-boards falls into an amalgamator; in other places the stamped stuff is allowed to run directly from the cofer into an amalgamator.[73] There are many contrivances for amalgamating gold with quicksilver. In Hungary and the Salzburg Alps there is one[74] called the Tyrol amalgamating mill, which has been in use for many years; it was expected when it was introduced there, that the defects of the other gold-extracting operations and the washing-bowl would be done away with; but it did not effect all this, though since it was brought into use a greater per-centage of gold has been obtained, principally in consequence of its catching the greatest part of the gold that is "stamped dead," before it is carried away into the "wild flood." These amalgamating mills lose[75] some quicksilver, which runs off with the tailings. An amalgamator which was

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[72] Plachen.

[73] This practice does not seem to be a good one, as it is necessary to have blankets after them to catch the particles of gold and mercury which escape. It is a better practice to concentrate the gold as much as possible, by means of riffle-boards or other appliances, before running the stamped stuff into the amalgamator.

[74] In *Phillips' Gold Mining and Assaying*, p. 112, and in other works also. a description of this apparatus is to be found.

[75] Some years back about 2300 tons of "stuff" were amalgamated in 32 mills, and a loss of 35½ lbs. of mercury incurred. *Wehrle*, vol. ii., p. 535.

tried here several years ago, and which involved the principle of the Tyrol mill, with less frictional action, consisted of a cast-iron cylinder, in the bottom of which were several inches of mercury through which the "stuff" was forced by means of a screw, which worked in a tube fitted in the inside of the cylinder so as almost to reach the bottom; the stuff, after having passed through the mercury, was raised several feet, and then escaped into the wild flood. Another amalgamating contrivance which deserves attention is the shaking-table,[76] which has been extensively used in this country; it is self-acting, that is, it does not require any attendance. Its fault, perhaps, is, that as generally constructed, its discharge is not equal, if working well, to the discharge of the batteries to which it is attached. The proper curve of its sole-plate, its pitch, its stroke, and the speed at which it should travel, are too frequently determined at random, for they have not yet been made matters of that nice experiment and calculation necessary to make the shaking table act with satisfactory certainty. The shaking table is not much in favor at present, but eventually it will come into greater use. Other contrivances have been resorted to, such as amalgamating copper riffle-boxes, into which the stuff falls and is brought into momentary contact with the mercury, and then pressed out. All the amalgamators lose more or less mercury. To effect an amalgamation in practice where acids, &c., cannot be resorted to, it seems indispensable that friction should be used, and that there should be also ample time allowed to ensure a successful operation; none of those contrivances, therefore, which fail to combine both of these conditions can be looked upon as effective amalgamators. This opinion is fully borne out by the result of an interesting experiment[77] where

[76] It was first introduced here about 1856. Mr. Porter's patent is principally a modification of the discharge.

[77] Mr. John Powning, a shareholder in the Cornish United Company, Ballaarat, where the experiment was made, communicated the following facts:—The battery of the company consists of 20 stamps; average weight of each, 5 cwt.; number of blows per minute, from 60 to 65; pitch, from 9 to 9½ inches; quantity of water used, 120 gallons per minute. Twelve of the stamps had three common shaking-tables attached to them, of 11 feet length, having three curves in each, the first and second of 5½, and the third of 3½ inches; the length of the stroke being 5½ inches, and making 65 strokes per minute. They were charged with 90 lbs. of mercury. To the remaining 8 stamps were attached two deep, copper amalgamating riffle-boxes, of

the quartz, the weight of the stamps, the number of blows, the quantity of water and all other conditions were the same, and the superiority of the shaking table over the copper riffle-box proved in the somewhat startling ratio of 144 to 1. A long amalgamated copper-plate contrivance, which has been in use at Bendigo, is well adapted to save fine gold, as it answers partially to the above-named conditions of friction and time. But all these amalgamators are capable of being materially improved by applying the agency of electricity[78] to them; this has been attempted to be used several times, but hitherto with indifferent results. It seems that the necessary condition is, that a different electrical state should exist, to ensure any degree of practical efficiency. It is unnecessary to enter on a description of the other processes requisite to bring the gold, after it has been amalgamated, into a fit marketable state, as they are all minutely explained in *Phillips' Mining and Assaying*, pp. 115, &c. The above is a general outline of the methods adopted for the extraction of gold from quartz-stone; but other additional appliances must be resorted to where the quartz-stone contains large quantities of pyrites, as is the case at the Whip Reef, Bendigo; at the Cornish United and Llanberris Companies, Gum-tree Flat, Ballaarat; at the German Reef, Tarrangower, &c. In the extraction of gold from auriferous ores of this description they are not to be calcined before stamping, unless they are partially decomposed, when they must be thoroughly calcined. For such undecomposed ores the process is to triturate them by the ordinary system of stamping, or otherwise, without calcining, as in the case of ordinary quartz-stone, up to the process of amalgamation, after which the sand, in place of being run off into the wild flood, should be diverted into pits, so partitioned as to compel it to travel a long distance before

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22 inches fall and 6 inches rise, charged with about 85 lbs. of mercury, the slide just touching it. The result was from the three shaking-tables, 35 ozs. of gold; and from the two copper amalgamating riffle-boxes, only 3 dwts.: the proportionate yield should have been 23 ozs. 6 dwts. It would be a most interesting experiment to work Porter's tables against those of the Cornish United.

[78] "The quick and thorough taking up of the gold by the mercury depends on the electric state of the latter, the proper condition under which this is to be obtained is effected by warming the pan in which it is contained or by applying zinc plates, and submerging them in diluted acids. These appliances, however, present technical difficulties."—*Wehrle*, vol. ii., p. 535.

falling into the wild flood; and the divisions should be such as are calculated to separate the stuff into metalliferous sands of the same size, the latter being an indispensable condition to a perfect concentration[79] by washing. The further dressing of these ores can be effected in different ways, as by adopting the Cornish cleaning tye, used for the extraction[80] of stream tin. A much more effective process of mechanical preparation would be secured by adopting some of the different contrivances used, as percussion tables; these tables would answer for the purpose of concentrating the coarser stuff, while inclined tables, worked with a brush, might be used for the slime. Suspended and inclined tables would require a large quantity of water and an extra power to work efficiently. The concentrated pyrites have to be calcined in reverbatory furnaces until almost all the arseniurets and sulphurets have been decomposed and the iron is in the state of protoxide and peroxide. The gold from the calcined ore can be extracted by three different processes—by smelting it with lead ore or litharge and separating the gold from the lead by cupellation in a cupola furnace; by amalgamation, or by the application of chlorine, used in the same manner as practised by Plattner,[81]

[79] In the tailings of many stamping-mills in the colony many tons of pyrites are allowed to run off, and become lost, while they could be separated from the refuse by mechanical preparations.

[80] The process of concentration for dressing iron pyrites ores will have to be somewhat altered, for while the specific gravity of tin and of arsenical pyrites may be set down, in round numbers, as 7·0, that of iron pyrites is only 5·0.

[81] The process applied by Plattner, in 1848, to extract gold from poor ores by chlorine is based upon the fact that chlorine dissolves gold, chloride of gold being formed, whereas it hardly affects the oxides of other metals Plattner made his trials and assays with the refuse of the calcination of arsenical pyrites, from Reichenstein, in Silesia, which, on account of their poverty ($\frac{1}{10}$ to $\frac{1}{12}$ of a loth per ctr., that is, something over 18 dwts. to the ton), could not remuneratively undergo the smelting process The arsenical slags consist principally of sesquioxide, and protosesquioxide, and subarseniate of sesquioxide of iron. With this process Plattner was able to extract gold to the amount of from $\frac{1}{12}$ to $\frac{1}{13}$ of a loth per ctr. The gold was precipitated from the solution by vitriol of iron, but on a large scale it can as well be done by copper plates; according to Allain $\frac{1}{10000}$ part of gold can be extracted from pyrites, after calcining and separating the oxides of other metals, such as iron, zinc, copper, &c., by diluted sulphuric acid; and both the Perets, Allain, and Bartenbach, obtained gold in this way from pyrites at Chessy and St. Bel."—*Theorie und Praxis der Gewerbe, Von Dr. J. R. Wagner*, vol. i., p. 180.

for the extraction of gold from the refuse of the calcination of the arsenical pyrites, called arsenick abbräude of Reichenstein. It is essential in this process that all the iron should be in the state of peroxide. This last method is successfully applied at Chessy and St. Bel to extract gold from pyrites, the lower metals being first separated by sulphuric acid in a diluted state. It is highly probable that this process will be eventually introduced into this colony. Its chemical exactness highly recommends its use for such auriferous pyrites as German Reef, Tarrangower; Whip Reef, Bendigo; and the like. In some places [82] the smelting of poor auriferous quartz ores, or arsenical iron and copper pyrites, is effected in combination with argentiferous ores; but in such cases the smelting of auriferous gangues is accessary to the smelting of argentiferous ores, the smelter adding the auriferous quartz, or pyrites, or calcined auriferous pyrites, as required by the metallurgical process for the extraction of silver, in preference to non-auriferous fluxes, the quantities of which are definite, so as to form the proper slag. The gold in this process goes with the silver through all the metallurgical operations necessary for the extraction of the silver with which it is obtained; it is finally separated on D'Arcet's[83] plan, by sulphuric acid, &c. But it is seldom that auriferous ores are of that peculiar character, as in the case of the Nagyag [84] auriferous ores for instance, that smelting is the proper process to be employed in the extraction of their gold. The smelting of auriferous ores is an expensive process, and the greater proportion of gold obtained through it, compared to that extracted from the same ore by stamping, washing, &c., would by no means cover the expense of the extra labor. However, where applicable the smelting of auriferous ores can be divided into two principal metallurgical operations—the smelting of auriferous pyrites, with little or no gangue, and the smelting of auriferous quartz. The metallurgical process for the former would be:—1st, to calcine the pyrites in the open air, thus forming protoxide of iron; 2nd, to smelt the same in a reverbatory or blast furnace, with the proper mixtures of calcined

[82] In Transylvania, Hungary, &c.

[83] In the mint at Vienna this method is employed, on a large scale, to separate the gold from the silver.

[84] Transylvania. These ores are partly smelted with others at the smelting works of Zalathna.

and uncalcined lead, or litharge, slag, &c., so as to form a singulo silicate slag; by this process lead containing gold is obtained; and 3rd, to cupellate the auriferous lead in a cupola furnace, by which process the gold is obtained in a cake, which has only to be run in a crucible and poured into ingots. But the metallurgical process of smelting auriferous quartz [65] is a still more slow and expensive affair, because to slag the quartz into a bisilicate, it is necessary to mix it with its own weight of limestone, iron slags, or refuse from puddling furnaces, and singulo silicate slags; moreover, as a high degree of heat is required to form the bisilicate slags, [66] iron pyrites, and not lead ore, is the substance which should be added to collect the gold, thus adding another process to the treatment. The product of this first operation would therefore be an auriferous singulo sulphuret of iron, which would henceforth undergo the metallurgical process indicated for auriferous pyrites. These, then, would be the principles which

[65] Mr. Wilkinson has attempted to melt quartz, contrary to all metallurgical principles and experience; it is possible to smelt quartz, that is to slag it, but to melt it in furnaces without a combination with other substances is impossible. From the description of Mr. Wilkinson's experiment at Ballaarat, given in the public journals, it seems that hydrogen gas was evolved in the same manner as it is prepared in the hydro-carbon process of gas-making. By a connecting pipe the hydrogen gas was conducted into a furnace, where, mixing with atmospheric air, sufficient heat was to be originated to permeate and melt the quartz and free the gold. The result proved the fallacy of attempting to melt quartz. The aspect of the quartz when taken out of the furnace was very irregular, some pieces being well burned, others not sufficiently so, and others vitrified round the edges, or covered with a vitrious coating, the admixture of slates and pyrites forming very hard slags, which agglomerated and enveloped quartz, thus showing that it had not been melted, and had been unequally burned, being partially vitrified and agglomerated among vitrious slags. Metallurgically judging, it was very badly burned, for whilst some of it had not been acted on, other portions of it were vitrified, or slagged, and formed a harder substance than when unburned; thus the contrary result was obtained to what is generally looked for in burning quartz, so that Mr. Wilkinson's process is merely an expensive kiln, and has yet given no proof that it is any improvement whatever on the ordinary continuous-acting kiln.

[66] The following are the proportions which the writer adopted successfully in this case for smelting auriferous quartz, in a blast furnace 14 feet high:—7 cwt. of singulo silicate slags, as little of them as possibly convenient, 20 cwt. of auriferous quartz, 4 cwt. of auriferous singulo sulphuret of iron, 3 cwt. of iron pyrites, 12 cwt. of limestone, and 2¾ cwt. of gypsum.

are to guide in the smelting of auriferous ores, and they show how tedious and expensive the extraction becomes under them, and how remote the probability is of their being acted on in this country, where, for the present, at least, the necessary fuel, limestone, and fluxes, are so scarce. The extraction of gold from its gangues, as at present practised in this country, by stamping, washing, amalgamating, &c., is, in a general point of view, the proper course; but it would be more so if gradually modified and improved by the introduction of appropriate technical manipulations, the value and efficacy of which the writer has here briefly indicated, so as not to trespass beyond the limits of an essay.

"PICK AND PEN."

ESSAY

ON THE

MANUFACTURES MORE IMMEDIATELY REQUIRED

FOR THE ECONOMICAL

Development of the Resources of the Colony,

WITH SPECIAL REFERENCE TO THOSE MANUFACTURES THE RAW MATERIALS OF WHICH ARE THE PRODUCE OF VICTORIA.

MOTTO

"CIVIL ENGINEER."

BY CHARLES MAYES, C.E.

INTRODUCTION.

In accordance with an advertisement emanating from the Royal Society of Victoria, dated March 28th, 1860, inviting Competitive Essays on four different subjects, I have turned my attention to the compilation of the Essay on Manufactures, the object of which is more particularly described in the words of the advertisement, which I have given on the title page.

In commencing this Essay I directed my attention first to the *Raw Materials* of the colony; the chief of these will be found in the following list, which I have divided into three parts, distinguishing the Mineral, Vegetable, and Animal productions, with a succinct account of the manufactures to which they are applied, omitting those productions that are not likely to be produced to a sufficient extent for manufacturing purposes :—

MINERAL SUBSTANCES.

Name.	Application.
Basalt	When liquified by icineration it has been cast into chimney-pieces, &c.
Clay (pottery)	Bricks, tiles, earthenware, stoneware.
„ (fire)	Firebricks, pots for melting glass, *Saggars* or boxes for baking pottery, porcelain &c., for lining and luting furnaces, for crucibles, retorts, &c.
„ (kaolin or china) ...	Porcelain, delftware, crockery, &c.
Cement stones	Cement or hydraulic lime.
Coal	Coke, gas, tar ; and from coal-tar is produced coal-tar oil, naphtha, pitch ; ammoniacal liquor, from which may be produced sulphate, carbonate, muriate, &c., of ammonia. Soot from coal also yields carbonate of ammonia.

Name.	Application.
Feldspar...	Glass, porcelain, glaze for pottery.
Gems—viz., diamonds, topaz, beryl, opal, aquamarine, garnet, tourmaline, sapphires, ruby, quartz crystals, &c.	Diamond for cutting glass, and for diamond powder. Gems generally for jewellery.
Gold	Bullion, jewellery, gold leaf, &c.
Iron (native), ores, hæmatite, carbonate, titaniferous sand, &c.	Cast and malleable iron, steel, &c., for conversion into hardware or ironmongery, and for medicinal purposes.
Limestone	Lime for manure, mortar, flux, &c. Limestone mixed with alumina or clay forms (when calcined) cement and hydraulic lime.
Manganese (oxide)	Glass of certain kinds, enamel.
Quartz (milk)	Glass, substitute for flints in pottery; with an equal portion of alumina or disintegrated feldspar it forms an infusible fire-clay like *kaolin*, as a substitute for sand in the preparation of clays for earthenware, and for forming moulds in foundries.
Salt from salt lakes, and from sea water	Crude carbonate of soda or soda ash for glass and soap, pure carbonate of soda, muriatic acid, &c.
Sludge from puddling-machines	Bricks, tiles, pipes, and other earthenware.
Tin ore (stream tin, also known as "black sand")	Block tin, tin plates or sheet tin, bronze, pewter, tinfoil, mordaunts, enamel, glazes for crockery, &c.

Other minerals have been found of great value in manufactures, but not hitherto in sufficient quantities to render them important in a commercial point of view; the chief of these are sulphuret of antimony,* sulphuret of iron, bismuth glance, Tripoli, sulphur, silver ore, galena or argentiferous lead ore, copper ore, &c.

If sulphuret of antimony, or sulphuret of iron (iron pyrites), could be found in sufficient quantity they might be used in the manufacture of sulphuric acid, but these materials for such a purpose have been elsewhere superseded by sulphur and nitre.

* From a pencil note by J. W. Osborne, Esq., in the margin of the manuscript of this Essay, I find that the owner of a quartz reef near Heidelberg told him that he had shipped several tons of antimony ore from that locality, to be calcined, at a considerable profit.—C. Mayes, June 24, 1861.

VEGETABLE PRODUCTIONS.

Name.	Application.
Arrowroot plant	Arrowroot of commerce (*a sample of arrowroot grown in Victoria was exhibited at the Victorian Exhibition*, 1854).
Almond (sweet and bitter) ...	Unctuous oil for perfumery, soap, &c.
Bark(wattle, blackwood, acacia, eucalypti, &c.)	Tan (chiefly from wattle), used in tanning leather, and for this purpose exported into England, &c.
Barley (various), bere, or bigg	Meal, pearl barley, malt, pale and dark, malt vinegar; with bere and juniper berries Hollands gin is produced by distillation; from these *cereals* are also produced whiskey and other spirits.
Beetroot...	Sugar as in France, beer, &c.
Beans (French)...	Pickles, stalks calcined for potash.
Carraway seed (A)	Essential oil for perfumery, &c.
Cucumber	Unctuous oil of commerce, and pickles.
Castor-oil plant (A)	Castor-oil as an unguent and medicine.
Colza-oil plant (A)	Colza oil for lamps, pigments, &c.
Cabbage and cauliflower ...	Pickles.
Flax (inner bark of)	Cordage, string, twine, potash from stems.
Fruits (apricots, pears) ...	Dried fruit, jams, perry from pears.
„ (apples, raspberries) ...	Cyder, raspberry vinegar, preserves.
„ (currant, gooseberry) ...	Wine and jams, preserves.
„ (elderberry)	Wine, and with grapes port wine.
„ (plum fruit and kernel)	Jam, preserves, and plum-kernel oil.
„ (cherry and kernel) ...	Ditto ditto, and cherry-stone oil.
„ (peaches)	Ditto ditto, and dried peaches.
„ (bergamot, A)	Essential oil for perfumery, &c.
Gum acacia, &c.; wattle gum, &c.	Varnishes, medicine, in textile manufactures for stiffening silk, crape, &c.
Grapes	Wine, brandy, jam, &c.
Grape seed	Grape-seed oil; the lees of wine, when calcined, yield more potash than any other substance, about 16 per cent.
Hemp	Ropes, canvas, or sail-cloth, &c.
„ seed	Unctuous oil.
Hop plant	Hops for brewing, &c.
Jessamine (blossoms)	Essential oil for perfumery, &c.
Lavender	Essential oil for perfumery, &c.
Linseed-oil plant	Oil for pigments, and linseed-oil cake.
Maize	Meal, beer, sugar, paper, and potash from the calcined stems.
Mulberry tree	Food for silk worms, fruit for jams.
Narcissus (blossoms)	Essential oil for perfumery, &c.
Olive tree (A)	Olive oil for salad oil, soap, &c.
Oats (various)	Oatmeal and groats, oats for whiskey.

Name.	Application.
Onions	Pickles.
Oranges (blossoms, &c.) (A) ...	Fruit for marmalade, blossoms for *Neroli.*
Paper plant (A)	Cotton and flax, grown in Wisconsin, U.S.
Poppy	Unctuous oil, opium of commerce.
Potatoes (various), and sweet potato.	Beer of Strasburgh, British brandy, starch, sugar; potato pulp is a good substitute for arrowroot.
Peach blossoms	Essential oil for perfumery, &c.
Rape-seed oil plant	Rape-seed oil.
Roses	Otto, or essential oil of, for perfumery.
Sassafras tree	Bark used in medicine (indigenous).
Straw of wheat, &c.	Straw plait for hats and caps.
Sunflower	Seed for oil, stems calcined for potash.
Sorghum saccharatum ...	Sugar, and the stems for paper and potash.
Trees (native)	Baskets (at Victorian Exhibition, 1854).
„ bark of ditto	Substitute for flax and hemp in the manufacture of cordage, paper, &c.
„ leaves of gum, &c. ...	Olefiant gas and spirito-crude oil,* made at Kyneton Gas Works.
„ branches and twigs ...	Potash, pyroligneous acid or wood vinegar, acetic acid, &c.
„ timber (waste)	Charcoal, wood vinegar, wood tar, pitch, creosote, potash, and gas.
„ timber (seasoned) ...	Coachbuilding, gigs, buggies, land and railway carriages, cars, carts, drays, wagons; also for furniture, turnery, woodenware, lasts for shoes, &c.
Thyme and rosemary	Essential oils for soap and perfumery.
Tobacco (Havannah)	Tobacco for smoking, and for cigars, twist, sheepwash, snuff, &c.
Thistles (full grown)	Potash to the amount of 4 per cent.
Violet (blossoms)	Essential oil for perfumes.
Vanilla (A)	Chocolate, confections, and perfumes.
Wheat	Flour, bread, biscuits, confections, starch, macaroni, vermicelli, whiskey, and other spirits.
Walnut (fruit)	Pickles and walnut oil.

Those plants, &c., which, as far as I can ascertain, have not been acclimatized I have marked with the letter (A), thinking it better that all doubtful productions should be kept distinct from those that have been fairly tried and found successful.

* Spirito-crude oil is the name given by the patentee who invented and manufactured this gas, &c., at the Kyneton Gas Works. See Specification of Patent in the Registrar-General's office, Melbourne.—C. Mayes, June 24, 1861.

ANIMAL PRODUCTS.

Name.	Application.
Blood and offal	Carbonate of ammonia.
Bones	Combs, brushes, spoons, knife and fork handles, &c., waste bone for manure, lampblack, animal charcoal or bone ash, carbonate of ammonia, &c.
Bristles (hogs)	Toilet brushes, painters' brushes, &c.
Calves and neats' feet	Jelly, neatsfoot oil, glue, &c.
Entrails or guts	Strings of musical instruments, &c.
Furs of opossum, kangaroos, rabbits, &c.	Nap for felt and stuff hats, and for the best kinds of felt.
Fish (various), whale, and fish bones.	Cured and dried, whale oil and fish oil, spermaceti, isinglass from fish bones.
Horns	Cups, flasks, combs, knife and fork handles, rings, carbonate of ammonia, &c.
Hoofs	Glue, ammonia, and substitutes for horn.
Hair from cows, dogs, horses, cats, &c.	Hair felt for roofing, coating boilers, inodorous felt for partitions, felt hats, &c.
Lard (hogs)	Porcine oil, pomades, confections.
Meat (butchers')	Bacon, hams, beef, cured and spiced; beef and pork, pickled or salted.
Ordure of horses	Ammonia and nitre from nitre beds.
Sheeps' feet	Sheep-trotter oil, glue, and ammonia.
Skins (horses hides)	Cordovan for saddlery, shagreen for cases, glue, and ammonia.
„ (hides of oxen)	Sole leather; waste hide for glue.
„ (calves)	Upper leather and *kip;* ditto.
„ (pigs)	Leather for saddles; ditto.
„ (kids and dogs)... ...	„ for shoes, gloves, &c.
„ (goats)	Morocco or Turkish leather.
„ (sheep)	Parchment, size, housings, &c.
„ (kangaroo)	Upper leather for dress boots, shoes, &c.
„ waste (all kinds) ...	Glue or gelatine, ammonia, &c.
Tallow (beef and mutton) ...	Soap, common and toilet, also common and stearine candles; anti-friction grease for railway and road carriages, machinery, &c.
Urine	Alum, tanning ley for Morocco and other leather; carbonate of ammonia, and nitre from nitre beds.
Wool (sheep, angola, alpaca)...	Woollen manufactures, cloth, &c.; woollen rags for carbonate of ammonia.

Such are the principal productions of Victoria, an infant colony, whose rapid growth and development is a source of wonder to the civilized world.

Mineral resources.

Our mineral resources, although unprecedented, are not yet fully developed, and are far from being explored by the practical geologist or mineralogist. Much important information may be obtained from the reports and maps that have been published by the Government Geologist, although they extend over a very small area as compared with the great extent of country, of which we know comparatively little as to its resources. It is not at all unlikely that we may yet discover lead, copper, antimony*, bismuth, zinc, silver, sulphur (from our extinct volcanoes), and other valuable minerals, in sufficient quantities for commercial purposes, and that we may discover hæmatite, the most valuable of the iron ores, in far greater abundance than we can at present have any idea of.

Acclimatization of plants in Victoria, &c.

All that we possess in the vegetable kingdom, with a few exceptions, are in the form of "acclimatized plants," imported from England, where they have been previously introduced and acclimatized since the reign of Henry the Eighth. The *Flora* of England includes upwards of 10,000 exotics, the whole of which might be acclimatized here, and, in addition, we may reasonably expect to acclimatize many plants and fruit trees which could not flourish beneath the withering effects of a British climate. Victoria possessing an average temperature at least 10° Fahr. hotter than England, would be found a more congenial climate for the acclimatization of plants, the indigenous production of climates whose average temperature is as much in excess of Victoria as that of Victoria is to England. When we are informed, on the authority of the *Société Zoologique d'Acclimatation*, that "green and red cabbage, onions, and parsley are from Egypt, beans from India, melons from Africa, lemons from Media, peaches from Persia, plums from Syria, &c.," we may with good reason hope to acclimatize the orange, castor-oil plant, &c., originally from India, especially when we know that several plants which grow to perfection in England are also from India.

Acclimatization of animals.

In the animal kingdom, too, who can tell the vast benefits we are likely to derive from the introduction and successful acclimatization of the "alpaca," the South African "eland," and the "forty-two species of tropical

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* *See* Article on Antimony in Appendix.

Indian deer," which the enterprising English expect to acclimatize in England—a climate so widely different from tropical India; may we not, with much greater chance of success, acclimatize these animals in Victoria, in conjunction with the camel, dromedary, and regal koodoo. The introduction of the British salmon, and other commercially valuable fish, to the lakes and rivers of Victoria, are likely to be shortly accomplished, and we may yet derive vast benefits from their successful acclimatization, benefits that will bear a favorable comparison to those that have for so many years been obtained from the salmon fisheries of England and Scotland.

Irrigation.

The vegetable productions of Victoria, which are already produced in good average crops, will be considerably augmented by irrigation; this will naturally follow the storage of water, now occupying some of our amphitheatres and gullies in the shape of reservoirs. This subject is still further engaging the attention of the public mind in the contemplated water supply to the gold-fields.

Without entering into particulars of the vast increase likely to take place in our crops, from a good system of irrigation, we may safely anticipate a general increase of at least 50 per cent. in our agricultural and horticultural products, where irrigation can be successfully applied. A considerable increase will also take place from an improved system of farming, which we may expect from a reduction in the cost of farm labor, the application of machinery for the same purpose, and of manure (hitherto too much neglected) to enrich the soil and increase the produce. It will be seen, from the list of "raw materials" produced in Victoria, how much our success, as a manufacturing people, depends upon the economical production of agricultural produce; but even supposing we produced abundance of raw materials at a cheap rate, we must also possess cheap labor and good machinery for the successful conversion of such raw produce into manufactured articles used in the every day purposes of life.

High rents.

The greatest drawback to our manufacturing interests in 1852, 1853, and 1854, was the high price of labor, the demand having generally exceeded the supply for both skilled and unskilled labor; this has been the chief cause of the enormous rents demanded by the proprietors of household property, who have naturally demanded a rental of from five

to ten years' purchase, simply because they could generally dispose of their capital to equal advantage in other pursuits.

The great demand for artificers since 1854 has been upheld and maintained by the vast sums of money annually paid for the erection of our public edifices, the permanent construction of which might have been judiciously postponed for a few years, when such a fall in the cost of the labor required may be reasonably expected as would reduce the cost of the permanent public buildings to at least one-third less than their present cost. This reduction in the cost of our public buildings is the more important, when we consider that dressed bluestone often forms a prominent feature in their construction, which costs twelve times as much to work as dressed freestone costs in England. By waiting a few years we should have had an opportunity of testing the durability of our sandstones, which only cost one-third as much to work as bluestone, besides being of a more suitable color for architectural purposes. The same remarks apply to our Government railways; many of the bridges and viaducts of these railways being constructed chiefly of bluestone, and partly of fine dressed bluestone, in most instances crossing pastoral roads and streamlets, to be admired by our cattle and their stock-riders, our sheep and their shepherds, the only class of animals likely to visit them for many years to come, since they are far removed from the "busy haunts of men."* It is by such means we have upheld the unreasonable demands, and have been dictated to by the *tyrannical* class of operatives in Victoria.

Before any important manufactory can be established in Victoria, a very large outlay would be required for suitable buildings, and from one-half to two-thirds of this outlay would have to be paid for labor required in the buildings.

Injurious effect of trades unions.

During the years 1852, 1853, and 1854, although the wages of artificers were higher than they have been since, it was simply the result of the great demand for such labor; but since then the various trades' unions have endeavored to maintain these high rates of wages, although the demand in consequence of such exorbitant rates has been

* Since writing the above, now nearly a year since, I find a growing disposition to dispense with fine-dressed bluestone on our Government railways, and otherwise to economise as much as possible.—C. MAYES, June 24, 1861.

gradually falling off: the result has been most disastrous to themselves and to the public generally, who cannot avail themselves of their services, but would rather allow their capital to accumulate in the banks until a more favorable opportunity occurs for investment. From the evidence given before the Tariff Committee* it appears there is a great want of employment among all classes of artisans, and, as it appears to me, from the very same cause, viz., a disinclination to work for less than a certain rate of wages which they consider they are justly entitled to, but at the same time admit that without an import duty of about 25 per cent. they could not compete with imported manufactures. This dearth of employment is not confined to manufacturing operatives; it also extends to artificers, such as masons, bricklayers, plasterers, carpenters, &c., not more than one-half of any of these trades' union operatives being constantly employed at their trades; the consequences being that they are poorer as a body than if they worked for two-thirds of their present fixed rate of wages, and were all of them fully employed—therefore the present assumed high rate of wages is really not the result of a legitimate demand.

Piece work cheaper than day work.

All classes of artificers, although refusing to be employed at per day for less than a certain rate of wages, will nevertheless take piece-work at such a price that they cannot possibly earn more than one-half the wages they profess to work for, unless, as is generally the case, they work harder at piece-work: thus ignoring in practice the principles they profess, besides deceiving the public as to the real value of their services. It thus appears that the artisans of Victoria are virtually on strike for the maintenance of a high rate of wages, while the money accruing from the labor of manufacturing imported goods of all kinds, amounting in the aggregate to several millions sterling per annum, is actually kept out of their pockets by their own obstinacy and blindness to their true interests; and what is more humiliating to them is the fact that they must and will ultimately succumb to such a reduction in their wages as will enable them to compete with imported goods which, if they can successfully accomplish, they may depend upon finding constant employment, and will at the close of each year find themselves

* A parliamentary committee which sat during the months of February and March, in 1860.—C. Mayes, June 24, 1861.

better off than they possibly could be while upholding a contest alike destructive to their own interests and that of the country at large.

In the foregoing remarks I have taken it for granted that all classes of artisans will do the same amount of work in a given time under all circumstances; this is only true when they work freely, and believe they are fairly paid, in this respect, as in the army, "one volunteer is worth two pressed men." We see a practical illustration of this important fact not only in convict labor but also in free labor, when men are employed in road making, and similar work under Government, they are dilatory and sluggish in their movements, and the expression "Government stroke" has become proverbial. The reason is obvious: the industrious active workman works side by side with others who do not earn half so much as he does, but who are, nevertheless, paid the same for their services; he soon finds that his superior industry is not appreciated, and consequently follows the example of his idle associates by adopting the "Government stroke." "Piece-work" has an opposite tendency, because, if a man knows that he must get through a certain amount of work to obtain a certain payment, he will naturally exert himself more than he would do if paid by time, without regard to the value of the work executed. Piece-work also stimulates emulation, because when a man finds that he is not earning so much as his fellow-workman, whom he regards or wishes to regard as his equal, he will naturally strive to improve, and will exert himself to the utmost in so doing; in fact, the energies and physical endurance of workmen are most fully developed by piece-work. On the contrary, any section of our free and independent skilled or unskilled laborers failing to prevent a reduction in their present high rates of wages, would, if they continued to work, soon show their disappointment by a corresponding diminution of their day's work, unless they could be convinced that they were being fairly dealt with; and it is a difficult task to make men believe they are as well off with lower wages, and that they ought cheerfully to submit to the inevitable laws of "supply and demand."

Day-work.

Piece-work.

Advantages of piece-work over day-work.

It would be better to introduce throughout the colony in every trade and manufacture the system of "piece-work," by which means every workman,

both skilled and unskilled, would have a direct interest in the quantity of work he got through from day to day and from week to week, while the employer would merely have to measure or otherwise ascertain the quantity of work done, and that the quality of the work was equal to that contracted for. The "trades' unions" of the colony are opposed to piece-work in principle or theory only, but not in practice as before shown. I have every reason to believe that the manufacturing interests of Victoria will succeed in proportion as the "piece-work" system is successfully adopted. The manufacturer will know what he can afford to pay (before he proceeds too far or gets beyond his depth) for a certain amount of work, which he will obtain from workmen who generally prefer their own trade to that of any other, or the great uncertainty of gold-digging, especially if they have been to the gold-fields and been unsuccessful, as most men have been. Supposing the "raw materials" employed in any manufacture to be as accessible here as in England, wages here will be always better than in England, by the difference in the cost of freight, brokerage, and other incidental expenses attending the importation of all kinds of manufactured articles.

Whatever the average earnings of our working classes may be, I am satisfied the same amount of labor will never be expended for daily wages as for piece-work, or for the desperation of anticipation displayed by the generality of our gold-miners.

Destitution.

In spite of the present high rate of wages paid to a few, who are not fully employed, the majority of our artificers and artisans, our laborers and laboring manufacturers, are almost destitute. They find little encouragement on the gold-fields, where the majority of the diggers are as badly off as the unemployed in Melbourne, and where the average earnings of all classes do not exceed 24s. per week by actual statistics.

The destitution in the colony is not confined to the male portion of the population; it is at least as bad, if not worse, among the female portion of our community. From a letter that appeared in the *Argus*, on the 20th June, 1860, I find that between "fifty and sixty persons applied for relief from the St. Peter's Church Poor Fund: seventeen of these were women whose husbands had left them with forty-two children, uncared for and destitute; eighteen were widows with forty-two children." The writer adds, "I do

not believe the above are one-half the persons in distress in this neighborhood, for many do not know that relief can be obtained, and therefore do not seek it." Collingwood is not the only colonial town with destitute women and children; Melbourne and its suburbs, Geelong, &c., also possess a like proportion, the greater part of which might be profitably employed in factories, instead of seeking relief from the parish or a *much worse alternative*, and which, hitherto, seems to have been their *only alternative*.

The high rate of carriage throughout the colony is another serious drawback to the manufacturing interests of Victoria; except in the case of isolated localities, where there is a good demand for an article, the raw materials of which may be procured in the same locality.

Government railways.

Even when our Government railways are opened, they will only benefit that portion of the colony in their immediate neighborhood, at least to any great extent; branch railways or tramways must be continued to other remote localities to obtain a cheap and easy communication. The construction of these railways (permanent though they undoubtedly are), with the present high rate of wages, to say the least of it, is a short-sighted policy; because we cannot reasonably suppose that the present wages (which are less than they were when the railways were let) can be possibly maintained; such an hypothesis is against all precedents, and *it is only on such a supposition, if at all, that an outlay of* £8,000,000 *could be justifiably expended on opening up* 250 *miles of the colony.* For the same outlay we might have constructed at least 2000 miles of tramway, which would have opened up eight times the length of country, embracing most of our available districts, and reducing the carriage to at least one-half of the present rates, even by a good macadamised road. Such tramways would have sustained the traffic of the colony for, probably, the next fourteen years, before which time we have every reason to believe our present two permanent lines of railway could have been constructed for £4,000,000 instead of £8,000,000, with the greater advantage of an increase in the immediate traffic, far greater than is likely to be the case in 1862, when our costly railways are expected to be opened.

Tariff Committee.

From the evidence given before the Tariff Committee during the months of February and March,

1860, (by coach-builders, carpenters, and joiners, cabinet-makers, pianoforte-makers, boot and shoe makers, curriers, saddle and harness makers, clothiers, tailors, potters, tobacconists, jewellers, tinsmiths, iron founders, plumbers, farmers, &c.), it appears the colonial manufacturers are unable to compete with imported goods, unless these goods are taxed to the amount of from 10 to 25 per cent; the latter being the duty generally advocated, and which about 80 per cent. of the Victorians would have to pay, in order that they, the minority of 20 per cent., might be enriched.

Most of the above witnesses agree that if they could only successfully compete with imported goods that there would be ample employment for the thousands of skilled and unskilled workmen, women and children, now almost destitute. That our colonial manufacturers should be able to compete with imported goods, and at the same time find employment for the unemployed and destitute, is ardently to be wished, if it could be brought about without taxing one portion of the people for the sole benefit of the remaining portion, and that the minority. It is better, even, that the interests of the few should be sacrificed for the good of the many; although the sacrifice, in this case, is not so great as they, the operative minority, seem to think it is.

Gold-fields.

The skilled and unskilled operatives of Victoria have been most injuriously affected by the gold-fields of the colony, and as long as any inducement is held out, either real or imaginary, for men to work at the gold-fields, with the most distant prospect of acquiring vast sums of money by some happy stroke of good fortune, they will not settle down to more legitimate and, as a rule, more profitable employment offered by trade, agriculture, and manufactures. 'Tis true there is a certain amount of uncertainty in all occupations, but in none so great as gold-mining; for although the average earnings of gold-miners, and the gold-fields population generally, does not exceed 24s. per week; it is a well-known fact that the majority of the gold-diggers do not earn probably more than half this, and are consequently reduced to the greatest straits and destitution, which is aggravated by the thought that they have been reckless and extravagant during the short time they were more fortunate; but they will often continue to persevere, after repeated failures, with an amount of industry and

perseverance, which, if applied in any other direction, would have met with certain reward.

If our laboring classes would be contented with an average remuneration of even 30s. per week, for the same amount of exertion that is expended on the gold-fields for an average of 24s. per week, we might successfully compete with imported goods, and there would be ample employment for all classes.

Colonial farming.

Ask any colonial farmer the value of the unskilled unwatched laborer on his farm, and he will tell you he is dear at any price; yet that same laborer has, in all probability, given ample proof of his ability to do a hard day's work at gold-digging, and would exert himself to the same extent for the same farmer, were he employed at piece-work.

Probably three-fourths of the failures in farming here might be traced to the inadequacy of the return for daily labor, as compared with the daily wages received by farm laborers. Another fruitful source of failure in colonial farming may be traced to the system of employing farm laborers at "board and wages." I know one farmer, at least, who has expended a fortune on his land, and has just filed his schedule in consequence, as far as I can ascertain, of employing day laborers and boarding them; he tells me, as a fact, which he can prove by his butcher's bills, that the quantity of meat consumed (or rather made away with) by his men was not less than 3 lbs. per man per diem throughout the year!! Such is the extravagance of men, the majority of whom would not consume one-half this quantity of meat were they to board themselves; nor is this a solitary instance, it is the rule rather than the exception in all similar circumstances.

Were farming to be conducted here in such a manner that every laborer on the farm would have a direct interest in increasing the produce, I have no doubt that farming would be one of the most profitable occupations of the colony. It is for the farmers to decide in what way this change can be brought about, but I have no doubt it could be so managed that unremunerative day labor on a farm should be the exception to the rule.

Land Bill.

The "Land Bill" (when remodelled) will do much to bring about a profitable mode of farming, and those farmers will (as a rule) succeed best who are least at the mercy of the day laborer.

The rate of wages is generally considered to be partly regulated by the cost of living, at least this is often the only reason given why wages should not be reduced. What can then be said of those workmen who demand from two to four times the rate of wages paid in England, when the cost of provisions and clothing together are not 10 per cent. greater in Victoria than in England at the present time; or in other words, men can live nearly as cheaply here as in England, with the exception of the item for rent; so that were wages here only 50 per cent. more than in England, our working classes would be better off than the working classes of England.

Rate of Wages.

As most manufactured articles are produced by machinery, the cost of motive power in Victoria must be a primary consideration; but as this forms the subject of another competitive Essay, I will merely call attention to the fact, that motive power can be distributed throughout the colony simultaneously with the "water supply," to which especial attention is now* being directed by the "Central Water Supply Committee," who has sent circulars to all the local bodies on the gold-fields for information as to their requirements, and the advantages to be derived from a copious supply of water in their various districts.

Motive power.

It cannot be too widely known that there are thousands of horses-power now lying dormant in the main pipes from the Yan Yean Reservoir, and that this inexhaustible power could be economically applied any where within a mile or two of the line of pipes, or in Melbourne; but the Commissioners of Water Supply, as if to check manufacturing enterprise, actually charge 4s. per 1000 gallons of water used, while at the same time the water of the reservoir would be vastly improved by being drawn off more copiously, serious proposals having been entertained of emptying the reservoir for this purpose.

Surely the Commissioners of Sewerage and Water Supply would confer a mutual benefit to their returns, and the public generally, by supplying water for manufacturing purposes at least, at say 1s. per 1000 gallons, which might be increased whenever any scarcity was apprehended. Our rivers also afford another source of motive power, not only in their present natural

* September, 1860.

falls, but also in construction of dams in suitable localities, throughout their available length. Were all the water wheels in England to be set aside, she would lose much of her motive power, and consequently her manufacturing prosperity. I might instance the Yarra Falls at Melbourne, where there is at least 1000 horses power continually running to waste in the busiest part of Melbourne. Very extensive mills might be erected over these Falls, without detriment to the river or its traffic;* or the water might be taken in culverts across Flinders-street, or in any other direction, so that after turning several undershot or turbine water wheels, it might again return to the Yarra below the Falls.

From the joint report of Capt. Pasley, R.E., and M. B. Jackson, C.E., furnished to Parliament, I learn that in consequence of the water of the Barwon River at Geelong being unsuitable for supplying Geelong with water, that they propose to construct a reservoir at Buninyong, by which means they contemplate being able to supply both Geelong and Ballaarat with pure water, the line of pipes being taken down the Geelong and Ballaarat Railway; should this bold scheme be carried out, it will afford the same facilities for motive power and irrigation, as is now offered by the mains from the Yan Yean, and generally throughout the colony similar advantage might be taken of the water, not only in its transit but also at its termini. Windmills will also afford another economical motive power, in all cases where its constancy will not be indispensable, as in raising water on to the high banks of rivers (as the Murray), into water holes or reservoirs to be used in summer, for the purposes of irrigation or even for motive power, where considered desirable.

Messrs. Dods and Co., plumbers, &c., of Melbourne, have lately invented and patented a *portable* engine of two horse-power, which can be worked by a half-inch jet of water from the Yan Yean service pipes; an inch service pipe would afford four times the power, equal to eight horses: by such engines many of the manufactured goods now imported might be economically produced in the neighborhood of the Yan Yean main or service pipes.†

* Since the above was written a bridge has been erected over these Falls. —C. Mayes.

† The *Argus* of the 15th inst., contains an account of "A simple and effective hydraulic machine of four horse-power, erected on the premises of

I consider that some inducement should be offered for the profitable establishment here of manufactories, which would induce experiments to be tried, and investigations made, to convert many of our raw materials into manufactured articles. Premiums.

For instance, let a premium of £1000 be offered by the Government for the first 100 tons of iron produced in Victoria, at 10 per cent. less than it could be imported; also, the same amount for 20 tons of rod and bar steel, made from charcoal iron, manufactured in the colony; also, £100 for a dinner service of delftware, equal to imported; and £200 for a similar service of china or porcelain, and so on with all those articles, the raw materials for which are to be obtained in abundance throughout the colony; the persons claiming the premiums to prove, by creditable evidence, that they have been and can again be produced for at least 10 per cent. less than the imported price of similar articles. £10,000 expended in this manner would, in all probability, cause £100,000 to be expended by enterprising manufacturers in endeavoring to establish manufactories. The gold-fields are particularly favored by the Government, who not only allow puddlers to deluge both public and private property with *sludge*, but also grant large sums of money to clear it away, to make room for more. They also invite premiums for the discovery of new gold-fields, and good building stone, &c., but offer no inducement to the people to establish manufactories, with the exception of passing a Land Bill, which may possibly help to lower the price of our raw materials.

"CIVIL ENGINEER."

September, 1860.

Messrs. Brown and Reid, Collins-street, east." This machine grinds one ton of coffee per day, at a cost for water of less than two shillings per ton. This is the whole cost of the motive power, which is derived from the Yan Yean service pipes.—C. MAYES, June 24, 1861.

NOTE.—In the following Essay I have adopted the alphabetical order observed by Dr. Ure, in his Dictionary of Arts, Manufactures, and Mines; which invaluable work has been my text book throughout.—C. MAYES, June 28, 1861.

THE

ECONOMICAL MANUFACTURES OF VICTORIA.

ALCOHOL.

Alcohol is the intoxicating principle produced by the vinous fermentation of liquors containing saccharine matter, or sugar. Common alcohol, or proof spirits, contains an equal quantity of absolute, or pure alcohol and water. It may be concentrated by water-bath heat to such an extent as to contain only 11 per cent. of water. In distillation the strongest alcohol is given off by a temperature of 170° Fahr.; and if the water-bath is maintained at that temperature, the vapor will contain 93 per cent. of pure alcohol; if it is raised to 201°, proof spirit, or common alcohol, will evaporate. The main improvement in modern distilleries is in the skilful application of this important principle.

Alcohol may also be concentrated by being suspended in bladders, which possess the peculiar property of giving off water by evaporation, while the alcohol is retained within the bladder; in this manner any spirits below proof may be concentrated to 40° above proof in from six to twelve hours, by being suspended in a hot room: this simple and economical method is well adapted for obtaining alcohol required in the preparation of varnishes; should it be required for medicinal purposes, the bladders can be rendered innocuous by being washed over with isinglass.

Alcohol containing only 11 per cent. of water may also be obtained by adding dry carbonate of potash to any intoxicating liquor, when the spirit at once rises to the surface and floats on the water contained in the liquor acted upon.*

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* Dr. Ure.

Alcohol dissolves resins, essential oils, camphor, &c., forming varnishes, perfumed spirits, &c. It is also used for preserving animal substances in our museums, for combustion in spirit lamps, &c.

In 1858 spirits of wine were imported to the amount of £5300, and perfumed spirits to the amount of £13,000. We have here £18,300 paid for spirits consisting chiefly of alcohol, exclusive of £5900 paid for imported cordials.* Taking into consideration that ten shillings per gallon is paid into the customs for all imported spirits, including those now especially under consideration, and that spirits of wine may be obtained from inferior or bad-flavored spirits or wines, or from a fermented decoction of injured corn or grain, or damaged sugar, it seems more than probable that common alcohol, or spirits of wine, with spirits suitable for perfumed spirits, and cordials, may be obtained in this colony with advantage to the manufacturer.

Alcohol obtained from the above sources may be easily freed from the *fusil oil*, the property that imparts its peculiar flavor; which, although not objectionable in the preparation of varnishes, or preserving animal substances, or for spirit lamps, would render it unfit, until purified, for medicinal purposes, perfumed spirits, or cordials.

AMMONIA.

By referring to the list of animal productions given in the preface it will be found that ammonia is produced from blood, flesh, horns, hoofs, woollen rags, hair, waste and scrapings of hides, leather, &c. These are distilled in large iron retorts in France, the charcoal produced from them being made into Prussian blue. *See* "ammoniacal liquor," under article "gas."

APPAREL AND SLOPS.

Apparel and Slops were imported here in 1858 to the amount of £460,136. From the evidence given before the Tariff Committee in February last, I learn that "the whole of the imported apparel, or clothes, are of an inferior description, and that in consequence of tailors, vest-makers, &c, in England, working for one half the

* In 1859 we imported cordials, spirits of wine, and perfumed spirits, to the value of £213,297.—C. Mayes, June 24, 1861.

wages paid here, that this description of goods cost 25 per cent. more than those imported; that we make the better class of goods because they are not to be obtained by importation. Silk vests are imported from China, Singapore, &c., at very low prices; with all these drawbacks slop goods have been made here by women and sewing machines at such a price as to compete with similar imported goods; for our needle-women are glad to earn twopence per hour, which is at least double the pay at home. They are also making slops in Sydney for the New Zealand market."

"Womens' apparel is also made here by sewing machines at less than half the cost of hand labor. Silk bonnets are always made in the colony, because the drapers cannot get them imported to order." It would appear from the above that our importations of wearing apparel to nearly half a million per annum are likely to be rapidly reduced, since the charge for clothes made in the colony are approximating to the price of those imported.*

ALE.

We may apply the term "ale" to the whole of the liquor imported here under the head of "beer," which in 1858 amounted to £302,788 for bottled beer, and £273,136 for draught beer, together equal to £576,924. Judging from the magnitude of the importations, the colonial manufacture of malt and ale are likely to become of vast importance to our brewers and the public generally.†

ALE AND BEER.

Hops.—We may with reason expect in a few years to find sufficient hops grown in this colony to supply our wants without importing them; but, as this subject belongs to agriculture, I will proceed with the important fact that hops imported from Great Britain, from the efficient manner in which they are packed

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* On referring to the imports for 1859, I find that apparel and slops were imported to the value of £588,654, which shows an increase of £128,518; this may be owing partly to an increased demand and partly to small stocks on hand at the close of 1858. I have no reason whatever to suppose that the colonial manufacture has fallen off.—C. Mayes, June 25, 1861.

† In 1859 we imported bottled beer to the value of £269,327, and draught beer to the value of £395,292. Together equal to £664,619. Showing an increase of £87,695 as compared with 1858.—C. Mayes, June 25, 1861.

(by hydraulic pressure), and the care taken to preserve them from the effects of the voyage, arrive here perfectly uninjured by transit. "The essential oil in particular, the basis of their flavor, is preserved without decay." The first operation in brewing is—

Mashing.—"The quantity of water to be employed for mashing, or the extraction of the wort, depends upon the greater or less strength to be given to the beer. The seeds of the crushed malt, after the wort is drawn off, retain still about thirty-two gallons of water, and in the boiling and evaporation from the coolers forty gallons of water are dissipated from every quarter of malt, constituting seventy-two gallons in all, either absorbed by the *grains* or evaporated. The quantity of extract (or solid matter), per barrel weight which a quarter of malt yields to wort, amounts to about eighty-four pounds; this is ascertained by the saccharometer, and is the result of *three extracts.* The wort is now transferred into the copper and made to boil as soon as possible, and until it begins to boil the air should be excluded by some kind of cover; the hops are now added, and are boiled several hours, a longer time for the ales than for the beers; two or three hours are deemed long enough in many well-conducted breweries: if they are boiled more than five or six hours they lose a portion of their fine flavor. The quantity of hop to be added to the wort varies according to the strength of the beer, the length of time it is to be kept, or the heat of the climate where it is intended to be sent." For the strongest ale the rule in England is to take one pound of hops for every bushel of malt.*

Cooling.—The common cooler is a square wooden cistern, about 6 inches deep; this is not more than half filled with the boiling wort, which, when it reaches the cooler, is about 200°; here it is cooled down to about 60° for the fermenting tun. The cooling should be as rapid as possible to prevent acidity, for which reason *refrigerators,* or machines for rapidly cooling the hot wort, are generally used, with great advantage. The cooling takes place most rapidly at a temperature of from 50° to 55°; if it approaches the freezing point the steam will not so readily rise from the surface of the cooler. The frosts of England are therefore of no advantage in *cooling the wort.* It is also found that the cooling takes place more rapidly under a dry atmosphere

* Dr. Ure.

than a moist one of the same temperature: in this respect Victoria has certainly the advantage over England. For six months in the year our mean temperature does not exceed 60°; viz., from April to October.

Fermentation of the Wort.—As a rule it is well known that the best ales are those fermented and ripened at the lowest temperatures. "The ale of Preston Pans is the best substitute for wine which barley has hitherto produced." "The Scotch brewer does nothing during four of the summer months." Taking the mean temperature of summer at Preston Pans to be 60°, the same as at Dublin (being 2° lower than at London), it does not seem reasonable to suppose that the Melbourne brewers can brew good ale during the summer, when the average temperature is stated to be about 69°.

"The greater or less rapidity with which the worts are made to ferment has a remarkable influence upon the quality of the beer, especially in reference to its fitness for keeping." "The slower, more regularly progressive, and less interrupted the fermentation is, so much better will be the product." "The higher the temperature of the wort the sooner will the fermentation begin and end, and the less is it in our power to regulate its progress."

These extracts from Dr. Ure's article on "Beer" will show the difficulty (if not impossibility) of brewing good ale in this colony during the summer months.

Ripening.—This is a process now very little attended to since the brewers find it more advantageous to sell their beer when new, and consequently mild. "Hence six weeks is a long period for beer to be kept in London, and much of it is drunk when only a fortnight old." Thirty or forty years ago *good hard beer* was the boast of the day; but since then the English taste has altered to such an extent, that publicans must "draw it mild" to suit their customers, although there is always plenty of hard or old ale to be obtained in England by those who prefer it. This is not the case in Victoria, for, with the exception of the bottled ale imported from England, and which has generally been pretty well ripened by the voyage, (or was probably ripe when bottled or shipped in draught), we have nothing but *very mild* colonial beer, which is not worthy the name of ale.

The color of beer depends upon the color of the malt, and the time it is boiled. The malt is deteriorated by being over dried,

the palest, or least dried, making the strongest ale; and the darkest, or highest dried, the inferior beers, or porter.

If ale is brewed in this colony in the eight coolest months in the year, it might be properly kept and ripened throughout the summer, supposing suitable underground storehouses or vaults were constructed for this purpose. It is surely not so difficult to keep ale cool as it is to keep ice from melting; and yet large quantities of ice are imported and kept throughout the summer in Melbourne. If this colony ever becomes a wine producing colony, its wines must be kept throughout one or more summers to acquire that age and ripeness essential to the best wines: so it is with ale. If it is desired to produce colonial ale equal to either the best Burton or Scotch ales, I believe that nothing more is necessary than that it should be made with the same proportion of pale malt and hops of the best quality, the wort cooled down to and fermented at the proper (well-known) temperature, and then transferred to ripening tuns, to be kept at a low even temperature throughout one or more of our Australian summers.

There is always likely to be a great demand for cheap and mild, or new colonial beer; and I have no doubt also that if first-class Australian ale was to be manufactured here, it would tend materially to lessen the importation of English and Scotch ales, which are universally preferred throughout Victoria to our present colonial beer, and that simply on account of their superiority of flavor, strength, and wholesomeness.

BEER.

This is a name given not only to a fermented infusion of malt, flavored with hops, but also to a fermented infusion of sugar, potatoes, carrots, turnips, beetroot, treacle or malt made from maize, wheat, oats, beans, or any other grain containing an adequate quantity of starch. If either of the above kinds of malt are used the process of brewing is the same as with barley malt. It is understood that if any of the above articles are used for the manufacture of beer, that they are flavored with hops, otherwise the infusion would be more properly called wine.

When either potatoes, carrots, turnips, or beetroot are used, they are boiled in water and mashed into a pulp; this pulp is mixed in the copper with corn meal, a proper quantity of water being added, the whole is boiled together for a short time, when

the hops are added, and the boiling continued for about eight hours; this wort is allowed to cool in the usual way, and fermented with the addition of yeast. "The celebrated Strasbourg ale is made from mashed potatoes mixed with about a tenth of their weight of finely ground barley malt and some water; this mixture is exposed in a water bath to a heat of 160° Fahr. for four hours, whereby it passes into a saccharine state, and may then be boiled with hops, cooled and properly fermented into good beer."*

Although potatoes were imported into Victoria in 1858 to the amount of £107,500, I have known several instances of good crops of potatoes being left to rot in the ground simply because the producer had no use for them, and they were too far from a market (on account of very bad roads) to pay for cartage. Beer is made in Germany from a mixture of barley-malt and beetroot-sugar, also from a mixture of barley-malt, potatoes and beetroot-syrup, and another kind from refined beetroot-syrup alone.

"Considerable interest among men of science, in favor of the Bavarian beer process, has been excited ever since the appearance of Liebig's *Organic Chemistry*. In the introduction to this admirable work, he says: "The beers of England and France, and the most part of those of Germany, become gradually sour by contact of air. This defect does not belong to the beers of Bavaria, which may be preserved at pleasure, in half-full casks as well as full ones, and without alteration by the air. This precious quality must be ascribed to a peculiar process employed for fermenting the wort, called in Germany *untergährung* or fermentation from below, which has solved one of the finest theoretical problems." Dr. Ure then explains, at great length, the chemical processes of this manufacture, which, on account of the difficulty in preventing ale or beer from turning sour in a hot climate, might probably be pursued here with great advantage. He says, "Neither the richness in alcohol, nor in hops, nor both combined, can hinder ordinary beer from getting tart, unless it is preserved in large ripening tuns, well closed, well filled, covered with sand on the top, and kept at a low even temperature;" but, even with these precautions, it will not keep in small casks, on account of the transpiration of air through the pores of the wood, the surface being much larger, in proportion to the quantity of ale in the

* Dr. Ure.

small cask, than it is in the immense ripening tuns made to hold 5000 or 6000 barrels. "The grand secret of the Munich brewers is to conduct the fermentation of the wort at too low a temperature to permit of the acetification of the alcohol." "The vaults in which the beer is fermented, ripened, and kept, are all underground, and mostly in stony excavations called *rock cellars*." * * * * "In December and January, (mid-winter), after the casks are charged with the summer or store beer, the double doors of the cellars are closed, and lumps of ice are piled up against them, to prevent all access of warm air. The cellar is not opened till next August, in order to take out the beer for consumption. In these circumstances, the beer becomes transparent like champagne wine; and since but little carbonic acid gas has been disengaged, little or none of the additionally generated alcohol is lost by evaporation."*

Lager Beer.—"In Bavaria, where this manufacture is carried on under Government inspectors, a brewing period is prescribed by law, which is, for the under fermenting Lager beer, from Michaelmas to St. George's day."*

About a year ago I received a circular, relating to Lager beer, from some party who had started a manufactory in Melbourne, on a small scale, stating the peculiarities of this beer, its price, &c., since which, I have heard nothing of it. It certainly seems strange, that among so many Germans, that one Lager beer brewery should not be maintained.

Porter and *Brown Stout* differ from ordinary beer, chiefly in the addition of the following ingredients, viz.: about two per cent. of kiln-browned malt, mixed with ordinary malt; 12 cwt. (for 180 barrels) of sugar, fused over a fire, into a dark, brown, or black syrupy mass; about three times as much hops as for beer, and 10 quarts (for 180 barrels), of *calfini*, a preparation made with the oil distilled from the outer bark of the birch, mixed with spirits of wine.*

Sugar Beer, as it is sometimes made in this colony, is a poor, sweet drink, but when properly mashed with hops, fermented, and ripened at a low temperature, it is of a quality superior to any colonial beer, in both flavor and wholesomeness, I have hitherto tasted. It can be made of any strength, according to the quantity

* Dr. Ure.

of sugar used; a beer of ordinary strength requires 1 lb. of sugar, and 1 oz. of hops to the gallon; this may be increased to 2 lbs. of sugar, and 2 ozs. of hops per gallon, for a strong, heady, bitter beer. If this beer be kept for six months, at a low temperature, (being bottled at two months), it will be found to be clear, sparkling, and fine flavored, and inferior only, to the best English ales. I write this from actual experience, having drank such beer for the last seven years.

The number of breweries in Victoria, in 1858, is stated, in our Blue-book, to have been 55; of which number, 10 were to be found in Melbourne and Collingwood.*

I have no means of ascertaining the quantity of beer brewed, or even the quantity of malt used, because, independently of the quantity of malt imported, there were, and are now, several malt-houses in the colony; neither can we ascertain the quantity of sugar used, even by those who profess to brew from malt and hops alone. Mr. Greeves, M.L.A., stated in the House, on the 20th July last, that "750 tons of sugar per annum, were said to be used in one district alone." Mr. Howard, M.L.A., also stated, the same evening, when introducing the proposed Beer Bill, that "in Sandhurst, two hogsheads of beer were brewed for every man, woman, and child, per annum." Reckoning 1 cwt. of sugar to be used in the manufacture of 2 hogsheads of sugar beer, which, without any other saccharine matter, would produce a light, palatable, wholesome drink; 750 tons would supply a population of 15,000 with 2 hogsheads each. According to Dr. Ure, sugar should yield its own weight of proof spirit, when properly fermented: at this rate the last-mentioned beer would contain 5 per cent. of absolute alcohol, and be equal, in strength, to brown stout.

Colonial Beer.—In June, 1860, an attempt was made by the protectionists of Victoria to impose a tax upon imported ale, with the view of encouraging the manufacture of colonial beer. This movement called forth a vigorous article in the *Argus* in condemnation and abuse of colonial beer, which was stated to be anything but what our colonial brewers would wish it to be

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* In 1859 there were only forty-six breweries in Victoria, thirteen of which were in the county of Bourke. *See Archer's Statistics for* 1859.—C. Mayes, June 28, 1861.

called, or even known by. As was to have been expected, this article called forth a reply by one of the leading brewers in Melbourne, wherein he states "that he feels assured the leading journal of the colony would not willingly or wilfully promulgate statements at variance with fact, and calculated not only to produce an unpleasant feeling in the public mind but materially injure a rapidly growing and important branch of colonial industry." He also says: "As one of the largest manufacturers of colonial ale, I respectfully invite you, or any scientific gentleman, to test my manufactures." And further: "I utterly deny that any unwholesome ingredient is used in the manufacture; the most common description of colonial ale which is manufactured is as pure as beer is possible to be, and being less fermented than that which is imported contains a smaller alcoholic per-centage, to say nothing of those deleterious ingredients which it is generally believed are introduced into imported beer to enable it to stand the voyage." The former part of this last statement ill accords with the latter part, for although this brewer may not use any unwholesome ingredient in his brewery, it does not follow that others are equally conscientious; and, on the other hand, he does not scruple to allude to "those deleterious ingredients which it is generally believed are introduced into imported beer to enable it to stand the voyage;" from which we might infer that no genuine English ale ever reaches this colony in a sound state. I would refer to one of the greatest scientific authorities on brewing, viz., Dr. Ure, to bear me out in the statement, that no deleterious ingredient is necessary to preserve beer, and also that even the best English ales cannot be kept sound in ordinary casks except at a low temperature, which, I imagine, may be found even in the depths of a well closed hold of a ship while crossing the line. I have no opportunity of ascertaining the quantity of *pricked* or sour beer landed in Melbourne, but I have no doubt it will be found larger in proportion in draught than in bottled ale, on account of the porous nature of the wood forming the casks. W. Hull, Esq., J.P. (in his evidence given before the select committee on the "Licensed Publicans" Act, in June, 1860) says, "Ale is damaged on the voyage or after being landed;" he also adds, "but that ale will make splendid vinegar." And again, "All the vinegar I have used at my house for the last two years I have made myself from this beer." So far so good, but he also

states, "I believe that those *pricked* (sour) beers are used by the brewers here to get up their own making more quickly; they have not capital to hold;" adding, "Beer that is *pricked*, however much it may be *doctored* by the publican, nauseates the palate." This I conceive to be important evidence, inasmuch as it seems to me to be one of the reasons that some of our colonial beer has the peculiar flavor by which it may generally be distinguished, viz., a sweet flavor or mildness from insufficient fermentation, coupled with a slight acid taste, either from mixture with *pricked* beer, too rapid fermentation in a heated atmosphere, or carelessness in *mashing*, whereby part of the wort is converted into vinegar. Pricked beer cannot be restored to its original quality, and it will also impart an unpleasant flavor to mild beer if mixed with it; indeed, this is the very system that is pursued in converting alcoholic drinks into vinegar, viz., *by the admixture of vinegar*, which accelerates the acetous fermentation, in the same manner that yeast acts upon *worts* in the vinous fermentation. It should be borne in mind by colonial beer drinkers, that mild or sweet colonial beer, even if a little tart, can, when bottled or otherwise securely corked, be brought round by the secondary fermentation of the undecomposed (gluten and starch, or) saccharine matter, in a genial temperature, to a flavor and strength superior to any it had previously assumed on account of imperfect fermentation in the first instance. The brewer before alluded to in another part of his letter in the *Argus* says, "No expense being spared in machinery or supervision, or to obtain the necessary ingredients, what is there, I would ask, to prevent as good and wholesome a beverage being manufactured here as in England?" In answer to this important question I would refer the reader to Dr. Ure's remarks under the head of "Fermentation of the Wort;" and also to the process of "Ripening;" and lastly, to the grand secret of the Munich brewers, as stated under the head of "Beer."

The *Creswick and Clunes Advertiser* of June 29th, 1860, gives an account of a brewery at Cabbage-tree flat; it states, "The brewery, 48 feet by 14 feet, is three stories high, the *cellar ten feet underground*, boarded, and everything complete with working puncheons, troughs, &c. A constant supply of pure water enables the proprietor to keep up a moderate temperature even in the hottest weather." I believe that such cellars, with a plentiful supply of cold water to encircle the fermenting and ripen-

ing tuns, are among the chief conditions necessary to improve the quality of colonial beer as now manufactured.*

BISCUITS.

I find that in 1858, 92 tons of biscuits were imported and valued at £6716. This refers exclusively to ship or navy biscuits.† Previous to 1831 ships' biscuits were made by hand, since then by machinery invented by T. T. Grant, Esq., of Gosport, in England. Dr. Ure, after describing the method of making ships' biscuits both by hand and machinery, says, "We have seen that 450 lbs. of dough may be mixed by the machine in four minutes, and kneaded in five or six minutes; we need hardly say how much quicker this is than men's hands could effect it. The biscuits are cut out and stamped sixty at a time instead of singly: besides the time thus saved, the biscuits become more equally baked by the oven being more speedily filled." The comparative expense is thus stated: "Under the old (hand) system, wages, wear and tear of utensils, cost about 1s. 6d., per cwt. of biscuit; under the new system (by machinery) the cost is 5d." He further adds, "The advantages of machine-made over hand-made biscuits therefore are many; quality, cleanliness, expedition, cheapness, &c." The biscuits imported here in 1858 cost us about 74s. per cwt.: reckoning the cost of manufacture here at 1s. 8d., or four times the cost in England, and the weight of the biscuits in flour at 23s. per cwt., we have a total cost of 24s. 8d., or one-third the imported price, leaving a profit, one would suppose, amply sufficient for any amount of capital expended in the erection of a suitable manufactory furnished with the best machinery. From the colonial Blue-book for 1858 I find there were five biscuit manufactories in Victoria in that year, three of which were in the county of Bourke. It would appear from this that there must be a great

* I would here call the attention of the scientific brewers of Victoria to the process of cooling the wort, that they may ascertain, by actual trial, whether it is better to use fans or cold water refrigerators. It appears to me that fans are objectionable, because "the impregnation of the saccharine liquid by the oxygen of the air is the object aimed at in the manufacture of Vinegar," which see.—C. MAYES, June 25, 1861.

† In 1859 we imported 114¾ tons, valued at £9879, or about 80s. per cwt.; shewing an increase in quantity and price as compared with 1858.—C. MAYES, June 25, 1861.

consumption of biscuits in this colony, for we find only ten tons exported, at 56s. per cwt.*

BRANDY.

The quantity imported into Victoria in 1858 amounted to no less than £447,546.† The best brandy is distilled from wine, and consists chiefly of alcohol or spirits of wine, each variety of wine producing a spirit peculiar to itself in flavor, which is due to an essential oil so powerful that a few drops of inferior oil are sufficient to taint a pipe of fine flavored spirit. Brandy is also distilled from a *wash* made from cherries, sugar cane, rice, corn, or potatoes, each kind having its own peculiar flavor by which it may be distinguished by *connoisseurs;* but flavorless spirits, as corn spirits sometimes are, may be converted into a factitious brandy by diluting the alcohol down to *proof*, then adding crude winestone dissolved in water, a little acetic ether and French wine vinegar, some bruised French plums, and flavor stuff from cognac; the mixture is then distilled with a gentle fire in an alembic furnished with an agitator. This new product may be colored with nicely burnt sugar, and roughened in taste with a few drops of tincture of catechu or oak bark; it will nevertheless be as wholesome as alcohol in any shape can ever be, and free from all deleterious drugs.‡

Latterly great attention has been directed (chiefly through our daily journals) to the cultivation of the vine, and the manufacture of wine in this colony.§ From the great success which has attended its partial manufacture in New South Wales, coupled with the opinion expressed by the first authorities in the colony, we may reasonably expect that Victoria will in the course of a few years become noted as a wine producing colony, if the restrictions as to distillation are removed, or even moderated; it will also

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* In 1859 there were six biscuit manufactories in Victoria, four of which were in the county of Bourke.—C. Mayes, June 28, 1861.

† In 1859 we imported brandy to the value of £422,790, shewing a decrease as compared with 1858, of £24,756.—C. Mayes, June 25, 1861.

‡ *See* Dr. Ure's *Dictionary.*

§ It may also be worth our while to cultivate and dry figs for the manufacture of brandy, &c. "The annual production of figs in the province of Algaroe in Portugal averages 11,238 tons, of which 2496 tons are consumed in the country, chiefly for making brandy, the price of which varies from 10 to 14 francs per cwt." *See* the *Argus* of November 14th, 1860.—C. Mayes, June 29, 1861.

simultaneously become as noted for its superior brandy as France now is, *i.e.* if its wines are equal to those of France, which we may reasonably expect they will be.

Illicit Distillation.—Even without wine or wine lees, an illicit distillation is carried on rather extensively throughout the colony, which leads me to suppose that if licenses were granted, and say one-half the duty on imported spirits, or 5s. per gallon was to be imposed upon all spirits distilled in the colony, subject to the test (as to strength and purity) of the revenue officers, that an important manufacture would spring up which would tend materially to reduce the enormous sum of nearly half a million sterling now paid for brandy alone, to say nothing of other spirits, such as gin, rum, and whiskey, amounting together to about £700,000 annually, expended by the Victorians, not on pure spirits, or even factitious brandy made from wholesome ingredients, but for the worst description of spirits, chiefly known as brandy, which, judging from the bad name it has got, is not even wholesome, and is probably made from damaged grain or bad potatoes, the bad flavor of which is due to an essential oil before referred to, called by the Germans *fusil oil*, and which may be separated from the spirits by a very simple process, rendering bad spirits almost flavorless and innocuous. In proof of the fact of illicit distillation being carried on in the neighborhood of our gold-fields, I will quote the evidence given by Mr. W. Jackson (a publican of Ballaarat,) before the Select Committee on the Licensed Publicans Act, on the 22nd February, 1860. He then stated "that illicit spirits could be obtained at Ballaarat from 10s. to 15s. per gallon, and from fifteen to twenty degrees over proof; it was sold as brandy, and could not easily be distinguished from cognac; and that it was made from rice, malt, or other grain." It was also stated to the same committee by William Hull, Esq., J.P., as to the quality of imported brandy that "Two-thirds of the brandy that comes here as cognac is made from a wash of potatoes in England. It (the brandy) is shipped to France or Belgium, where it is bottled and marked as Martell's, &c.; it is then shipped out here as the genuine article." He also states in clause 1401—"I endorse the remarks that Mr. King made a few minutes ago, that many hundreds of thousands of gallons are here at the present moment (June 12th, 1860) that will not be taken out of bond." * * * "It will remain until

it has *eaten its head off* in storage. It is not fit for consumption: the best thing that could be done with it would be to destroy it." He also mentions "that to prevent such imports in future, the revenue officers might be empowered to test and gauge all imported spirits, and refuse to pass or allow to be landed all of inferior quality."

Before the Government acted upon such advice as this, it would be perhaps advisable to put samples of these inferior spirits into the hands of their analytical chemist, that they might know what they really consist of, for unless the information furnished by Dr. Ure (in his *Dictionary of Arts and Manufactures*) is not to be relied upon, the objectionable qualities of inferior spirits are due, as I have before stated, to an essential oil which may be separated from the pure alcohol, the basis of all spirits distilled from fermented liquors or washes. If these bad spirits (which should yield to the revenue at least a quarter of a million sterling for duty alone) should be found incapable of being purified at a reasonable cost, they might probably be used for other purposes, such as for consumption in spirit lamps, or for varnishes, and other purposes to which alcohol is applied; but since "this noxious substance *fusil oil* is more volatile than alcohol, it may be drawn off by distillation in a concentrated state." The potato *fusil oil*, which is the kind we have to deal with, supposing Mr. Hull's evidence to be correct, "has at the first impression in its pure state, a strong, not disagreeable smell, which afterward becomes extremely nauseous, and excites an acrid burning taste. The inhalation of its vapor causes a feeling of oppression and vomiting." In consequence of the high price of alcohol in Great Britain, it is smuggled under various disguises; sometimes it is mixed with oil of turpentine, at other times with wood naphtha, or wood vinegar, coal naphtha, &c., from all of which deleterious mixtures it is freed by distillation and other processes.* I therefore see no reasonable obstacle to the purification of the immense quantity of inferior spirits now in bond, either by its importers, or other enterprising citizens purchasing it for this what appears to me to be a very laudable object.

Dr. Ure, in treating of distillation, says, the best "means hitherto discovered for depriving bad whiskey of its nauseous

* Dr. Ure.

smell and taste is to pass it through well burned and coarsely pulverised charcoal." This is distributed in layers alternating with layers of sand, the sand being separated from the charcoal by close canvas; casks or cylinders are filled with these layers and the spirits forced through. It has been found with very crude spirits that eight successive cylinders were required to deprive them entirely of the rank flavor. As the bad flavor of all spirits are caused by the presence of an essential oil, as before stated, it follows that they are alike susceptible of purification by filtration through charcoal, &c.

By an approximate summary furnished by the Registrar-General, on the 26th July, 1860, it appears that 477 gallons of brandy were made in the colony during the year ending 31st March, 1860.

BRICKS.

Bricks are of at least two distinct classes, viz., fire-bricks made from fire-clay or artificial substitutes for fire-clay, and common bricks or bricks calculated to withstand exposure to the weather only; in addition to this last necessary quality, fire-bricks will also withstand a furnace heat for at least three months. In consequence of the great improvements in the manufacture of colonial bricks which have gradually taken place since about 1853, the importation of bricks has gradually decreased, the quantity imported in 1858 being only 510,000, at a prime cost of about £6 5s. per 1000, and these were fire-bricks.

Fire-bricks, or bricks made expressly for furnace work, have not (as far as I have been able to ascertain) hitherto been manufactured in the colony to any great extent. That suitable clays exist I have not the least doubt; a natural compound of silica or sand and clay in about equal proportions, and free from lime, magnesia, or other flux, is the best fire-clay, and such clay exists in all coal-fields, those of Cape Paterson, Western Port, &c., not excepted. If the alumina or clay is in excess, and contains oxide of iron, as most common clays do, care must be taken "not to add too much siliceous sand, or a fusible compound will be produced." To avoid this, it is common to add waste fire-bricks, or burnt clay, or common brick rubbish, properly ground and mixed with the clay as a substitute for the sand; the pipe-clay of Bendigo has been used in this way with success.*

* See *Colonial Mining Journal* for September, 1859.

As manufactures requiring furnaces increase in this colony, fire-bricks will come into more general demand, as in the lining to brick, tile, lime, cement, or pottery kilns, the lining of cupolas for smelting iron, tin, and other metals, for coke and common ovens, setting retorts for gas-works, and boilers for steam-engines, &c., &c.; so that it is really important that this branch of our manufactures should receive greater attention than has hitherto been bestowed upon it.

Economy of Brickwork.—In consequence of the great expense of working "bluestone" and granite (the most durable of our building stones) and the fact of Bacchus Marsh and Darley stones being liable to exfoliation from the presence of sulphate of soda and other salts which permeate their entire substance to a greater or less extent, it seems more than probable that our building stones will be in many instances superseded by the manufacture of good bricks, especially where durability and economy are the primary considerations. It is a well-known fact which has been repeatedly proved by experiments, that brickwork is stronger than stonework, and that *brickwork in cement is stronger than either*, and yet brickwork in cement is only half the cost of dressed bluestone masonry, supposing the materials to be carted the same distance in both cases. I believe that at least £500,000 out of the £8,000,000 to be expended on our trunk lines of railway might have been saved if brickwork had been substituted for bluestone masonry in all cases in which suitable bricks could have been obtained as near to the work as the good bluestone quarries were; as it is and has been up to the present time, no trouble has been taken to search for suitable brick-earth in the neighborhood of great public works, although in many instances it would effect a saving of one-fourth of the total outlay.* The greatest difference in the relative cost of brick and stone work is in those cases where considerable labor is bestowed upon moulding the stone work; this is saved in the brickwork by the bricks being moulded (before they are burnt) in the process of their manufacture. The whole process of brickmaking I consider to be of such vast importance in developing one of the greatest resources of the colony, that I append a few facts on the principles and practice of brickmaking adapted to the requirements of the colony, the result of actual

* This was written in July, 1860.—C. Mayes, June 25, 1861.

colonial experience, and which may be considered under the following heads, viz.:—1. Brick-earth; 2. Weathering and Grinding; 3. Tempering; 4. Moulding; 5. Drying; 6. Burning.

1. *Brick-earth.*—The success of brickmaking depends mainly on the quality of the brick-earth used, for unless it is naturally good, or can be made so by the mixture of sand or other suitable material at hand, the greatest care in the preparation, moulding, and burning will not compensate for the inferiority of the raw material. Alumina or pure clay is or should be the principal constituent of brick-earth; but if the brick-earth consists wholly of pure clay, or clay containing not more than 30 per cent. of sand, it is useless for brickmaking, since it will not dry (even with the most careful treatment) without cracking, on account of the great shrinkage; it is also refractory in burning, the most intense heat being insufficient to bind the particles composing the brick together. As a rule it may be stated that bricks that are *easily dried are easily burnt;* but this property is not always a good one, because it is sometimes the result of the opposite extreme, and proves that the brick contains too much sand (like the Prahran bricks). The best brick-earth contains about equal proportions of clay and sand, and when these two ingredients are the only constituents of brick-earth, as in some fire-clays, it produces a most excellent fire-brick; and if (as is generally the case) the brick-earth contains oxide of iron, the sand and alumina being in equal proportions, a most excellent brick may be produced; but if the oxide of iron is in excess, the brick will be liable to fuse at a white heat. The quantity of sand contained in a certain quantity of brick-earth may be easily ascertained by washing away the clay in the same way that clay or washing stuff is puddled or washed on gold-fields. Although bricks containing sand in excess are easily burnt they are not fusible, nor can the particles be properly united without the addition of a flux, such as carbonate of lime in the shape of powdered chalk or limestone, or a larger proportion of oxide of iron than is generally found in brick-earth. Bricks made from pure clays not only shrink too much, but crack, and are rather *baked* than burnt; such bricks are hard and tough, and will not bear cutting. Pure clay may be improved by the judicious mixture of sand, and still more so by mixing breeze, or fine cinders, or coal-dust in very small proportions if intended to be burnt in colonial clamps. This process is not followed in Victoria on account of the

extra expense; but it is probable that the refractory clays overlying bluestone might be rendered more serviceable as brick-earth were this system pursued. I have no doubt that good brick-earth is to be found in most parts of the colony; it is very common in the silurian or gold-producing formation, also in the granite and tertiary formations. Were the washed clays or sludges of the gold-fields mixed with the washed sand (deposited by the sludge) in proper proportions it is more than probable that excellent *cutters* might be produced, which might be easily sawn and rubbed to any required dimensions, and also gauged or bevel-bricks for arches, Beveled bricks for gauged arches are now made at Brunswick, the price being about four times that of the best colonial bricks. With the washed clays and sand of the gold-fields, which now form the sludge nuisance, thousands of excellent *cutters* might be made at about double the price of ordinary bricks which, although of no advantage to Melbourne until the railways are completed, would in the meantime be of great value to Sandhurst, Castlemaine, Ballaarat, and other townships on the gold-fields. The rich cream-color of the London *malm-cutters* is produced by the mixture of chalk; and I have no doubt that calcareous clay might be obtained contiguous to limestone formations, as at the Heads, Geelong, Limestone Creek, &c., from which good cream-colored bricks, if not *malm-cutters*, could be produced at a reasonable cost.

2. *Weathering.*—It is customary in England to expose the brick-earth to the action of the frost, but in Victoria the clay is no sooner obtained than it is tempered and moulded, often in the same day; but this rapid manipulation can only be pursued with mild clays. It is usual to dig pits, about 18 inches deep, into which the clay is thrown, watered and opened, and allowed to remain for a day or two before it is tempered; it is then taken to the pugmill, or tempered by hand.

Grinding.—Although this process has been but little, if at all, practised in Victoria, it is one which is absolutely required to render some clay fit for bricks. Most excellent bricks have been made by Messrs. Cornish and Bruce, in the Black Forest, which seem to require only this process to place them among the best of colonial bricks. Whenever the brick-earth contains fragments of rock, or iron stone, it must be ground to render the mass homogeneous, and to prevent the bricks cracking, or flying while burning.

3. *Tempering.*—The object of tempering is to bring the brick-earth to a homogeneous mass, so as not only to be easily moulded, but also easily dried and burnt; the best brick-earth, if not properly tempered, will produce unsound bricks. The system generally pursued in Victoria is hand, or manual tempering. If a pugmill is used, a considerable saving will be effected after the the first cost, which is often considerable. As the pugmill requires a steady continuous motion, no animal power is so well adapted as steam or other mechanical power. If a pair of bullocks are used, they require too much looking after, not only in the pugmill, but out of it. Two inferior horses would "*eat their heads off*" if corn-fed, and one good horse, if strong enough, is too good to put into a pugmill, where he soon becomes fit for nothing else, even supposing he can stand the continuous collar work, which few horses can do. In brick machines, as in that of Clayton's, the tempering and moulding are performed simultaneously; but unless a large quantity of bricks (say a million) are required, it will not pay for a steam engine, and, as before shown, animal power is not to be depended upon, and is, therefore, unsatisfactory. The brick moulding machines imported here have a die, or mould, much larger than the colonial size, but which may be altered for a few pounds to any size required.

4. *Moulding.*—The system of moulding generally pursued in Victoria partakes of both the systems known as *pallet* or sand moulding, and *slop* moulding. There is little difference in the cost of slop and sand moulding, for although a sand or pallet moulder will turn cut three times the quantity of bricks in a given time, it is owing to his having the *clot* prepared for him, whereas in slop moulding the moulder prepares it himself; but in the system pursued in Victoria, although the mould is wetted, and the clot prepared by the moulder, as in slop moulding, the wet bricks are turned out on pallets and barrowed to the back ground, as in sand or pallet moulding. Although machines are occasionally used for moulding, yet the saving in the labor is so small, compared to the total cost, that except for large quantities of bricks, as before stated, there is little advantage to be derived over the more general system of hand moulding.

Dry-moulded Bricks are made from dry clay, which is reduced to powder, and afterwards pressed together by enormous pressure; they are then fit to handle, and may be stacked in the kiln, and

burnt forthwith, but they are generally inferior to the best samples of colonial patent wet-pressed bricks, the outside being generally harder than the inside, which is the last part of the brick to dry, and which, in drying, causes the outside to crack. The size of the brick-mould to produce a brick of a given size will depend upon the quality of the clay, pure clays shrinking more than mild clays.

Moulded and Angle Bricks.—Considering the great cost of moulded stonework, it is surprising that moulded bricks have not been more extensively made in Victoria, especially when such superior samples of white and cream colored colonial bricks are to be had (as may now be seen at the Building Museum) at about £7 per 1000.* Taking moulded headers at £1 per 100, delivered in Melbourne, I find, on referring to the *Victorian Contractors' and Builders' Price Book*, that the expense of moulded brickwork, as compared with moulded Bacchus Marsh stone, would not be more than one-third, or one-fourth of the cost of moulded Kangaroo stone, or one-sixth the cost of moulded bluestone. If moulded bricks are made larger than ordinary bricks, they are known as *terra cotta*, and must be perforated, so as to allow of their drying and burning without flying. If proper precaution is observed, the use of moulded bricks, and *terra cotta*, may be extended almost indefinitely, as in copings, cornices, strings, &c.; irregular-sided bricks are also in common use in England, and might be introduced here with advantage, such as radiated *stretchers* for well steining, made to radii of from four to six feet; splayed bricks for window jambs; bricks for octagonal chimney shafts, or walls, with one edge beveled to an angle of 135°, either of which kind of special bricks ought not to cost more than 30 per cent. more than the cost of common-shaped bricks of the same materials. Perforated bricks are made here, but I have seen none of equal quality to the best solid bricks; this may be owing to the inferiority of the clay of which they were composed, and not to the perforation.

5. *Drying.*—The principal point to be attended to in drying bricks is to protect them from the rain, wind, and sun, so that one side of the *hacks* do not dry faster than the other side, or they will be twisted and cracked. To effect this desideratum recourse is had to screens or *lieus*, straw, swamp grass, sacks, calico, matting,

* This was in August, 1860.—C. M.

felt, and tarpaulins; but all these appliances are but sorry substitutes for drying sheds, which should always be erected where a large quantity of bricks are required, as the saving effected in the cost of attendance and losses in the destruction of *green* bricks by the first method is soon saved by the use of drying sheds. The difference in the time and trouble required to dry different kinds of clay is very great; clays containing too little sand, require at least double the time and attendance in drying as compared with bricks made from mild clay. If ashes or coal-dust are mixed with the bricks, they must be thoroughly dried to resist the too sudden application of the firing; this is not of so much importance when they are free from fuel, because the heat can be applied more gradually. The drying generally takes from a fortnight to a month. The best bricks are sometimes dressed with a beater, when half dry, to improve their shape by rectifying any warping or twisting that may have occurred during the first stage of drying; but this improvement is more effectually performed by a press, when they are called pressed, or patent-pressed bricks.

6. *Burning.*—In Victoria, bricks are generally burnt in *clamps;* they are loosely packed, so that the heat may spread between them. This is also the method adopted in kilns, which are merely permanent casings, the casing in the ordinary clamps being merely loose bricks, half a brick thick at bottom and brick on edge at top, or upper part of casing; this is always plastered over with clay, so as to make the best of a poor substitute for a kiln. *A kiln is most economical* where a permanent brick-field is established, on account of the great waste of fuel and bricks, often attending the use of *cased clamps,* the continuous action of the wind from the same quarter, driving the fire from the weather side of the *clamp.* This can be partially guarded against by putting up screens next the end of the fire-holes exposed to the wind. The clamp or kiln is at first but gently fired, until the steam from the bricks ceases to rise; the top of the kiln is then covered up with a layer of old bricks, upon which is spread loam or soil to keep in the heat, the fires are then gradually increased, until the bricks are brought to a white heat, which can be seen in the dark through the casings; but this period in the firing must be ascertained from trial holes, when it occurs in the day time, or in a kiln, and also by the time and fuel used. After the bricks have been brought to a white heat, the firing is as gradually

reduced as it was increased to attain this heat; the fire-holes are then bricked up and plastered over with clay, and the clamp or kiln is allowed gradually to cool, the cooling not being hastened by opening the *clamp* or kiln too soon, which would impair the soundness of the bricks. A temporary roof is generally erected over the clamp, to protect it from the rain, which would otherwise do as much injury as the uncontrolled action of the wind in the fire-holes. Clamp burning, as practised in Victoria, takes about one measured ton of colonial hardwood to each 1000 bricks, made from mild clay, the purer clays requiring much more fuel. The wood used should be dry, but may vary from the ordinary size of billets to logs that require two men to handle effectually.

Kiln-burning.—Although not practised in the colony, it is to be recommended for the reason before stated. The simplest form of kiln is the rectangular or clamp form, the walls of which may be made of any thickness, from one-third to one-tenth their height, the thick walls being less liable to crack than the thin ones, and therefore more easily and cheaply kept in repair, and occasion less waste of firing. Narrow-arched openings are left in the sides for fire-holes, and a narrow-arched doorway at each end, through which the bricks are passed for stacking and unloading the kiln. The kiln having been fitted, the doorways are bricked up and plastered, and the same regulation and process is followed as before mentioned for clamp-burning. A leanto shed is generally put up on each side of the kiln, to protect the fuel, fire-holes, and firemen from the weather. I have no authentic data as to the saving in wood-fuel, but it may be safely inferred that bricks, when kiln-burnt, would not take more than three-quarters of a ton (measurement) of dry wood to the 1000 bricks, thus effecting a saving of at least one-fourth in the quantity or weight of fuel by kiln-burning over that of clamp-burning. Neither system of clamp or kiln burning here mentioned is pursued when coal-dust or breeze is mixed with the clay before it is moulded; when this is the case, the bricks should be closely stacked in the clamp or kiln, with a thin layer of breeze or coal dust between each course, and barely sufficient firing used to ignite the bricks next the fire-holes, each brick forming a fireball in itself, because it contains its own firing. The fire is rapidly spread throughout the kiln, which, in London, takes from a fortnight to a month burning, but there clamps are ten times the size of those hitherto used in Victoria, from which I

should infer that clamps of less than 100,000 bricks might be burnt in a week. Coal dust is too expensive to pursue this system here, but it remains to be seen how far sawdust may be substituted to produce a light brick suitable for arches, vaults, and domes, in the place of the very dense heavy bricks now made here in great perfection. In 1858 (I learn from the Blue-book) there were 149 brick-fields in this colony. Bricks vary as much in price in Victoria as in England; ordinary bricks may be obtained from £3 to £4 per 1000, but the best quality, such as the patent pressed bricks, are at least £5 per 1000 at the kiln. English fire-bricks, although stated to be imported here at £6 5s. per 1000 in the former part of this article, are seldom sold at less than £8, the general retail price being about £9 per 1000. Bricks nearly equal in quality to imported fire-bricks are now made in the colony, and sold at from £5 to £6 per 1000. As the good quality of these bricks become more generally known, they will doubtless eventually entirely supersede the importation of even fire-bricks.*

BONE BLACK.

Bone black or animal charcoal, is made by calcining bones in similar retorts to those used in gas-works. In 1858 we exported bones to the value of £3067 †; in the manufacture of bone black whether for animal charcoal or for ivory black, such bones as cannot be used for, and the refuse from, boneware, can be calcined with advantage.

Animal charcoal is said to deprive solutions, particularly syrups, of their coloring matter more readily than vegetable charcoal; 10 per cent. more of refined sugar can, also, be obtained from the raw material with animal than with vegetable charcoal.

The bones lose about half their weight by calcination in retorts, and the charcoal is ground and sifted before it is used.

Sal-ammoniac.—The condensed vapors issuing from the retorts, after undergoing several manipulations, are converted into "sal-ammoniac," or the muriate of ammonia of commerce. Since the general establishment of gas-works throughout England, "sal

* *See* the article on Bricks and Tiles, in the Appendix.

† In 1859 we exported bones to the value of £5135—C. MAYES, June 28, 1861.

ammoniac," and other preparations of ammonia, are made from the ammoniacal liquor, distilled with tar, from the coal used for generating gas. "In a chemical factory near Glasgow, 720 gallons of ammoniacal liquor are rectified by distillation, to which 450 lbs. sulphuric acid is slowly added, the produce being 240 gallons of sulphate of ammonia, which is decomposed by common salt. In the distillation of the crude liquor, 90 gallons of tar is obtained by subsidence, and 20 gallons of petroleum is skimmed off the surface. The tar is converted, by moderate boiling, into pitch." (See "Ammonia" and "Gas.") Ammonia, in the form of "sal-ammoniac, is principally used for tinning cast iron, wrought iron, copper, galvanised iron, &c., and also in medical prescriptions."*

BRUSHWARE.

Brushware was imported to the amount of £21,745 in 1858.† For the manufacture of brushes we have bones, hardwood, and bristles, among our raw materials, which are the three principal articles required; we have also horsehair and dogs' hair, which are used for some kinds of brushes. It is probable that kangaroo hair and even camels' hair may eventually be used for this purpose in Victoria.

BUTTER.

In 1858 butter was imported to the amount of £308,000. Although this is a pastoral colony, very little butter is produced here. An ordinary cow will produce 1800 quarts of milk per annum, which will readily sell at 8d. per quart=£60; this quantity of milk will produce about 140 lbs. of butter, which at 2s. per lb.= £14, or less than one-fourth the sum produced by the raw material. These are also the proportionate prices of new milk and fresh butter generally maintained in Great Britain. We cannot, therefore, reasonably expect any great increase in the manufacture of colonial butter without a corresponding consumption of milk, which is not likely to take place without a proportionate increase in the population, unless in those instances where dairy farms are

* Dr. Ure.

† In 1859 we imported brushware to the value of £20,215.—C. Mayes, June 28, 1861.

established at too great a distance from any milk-walk, and yet at a convenient distance from a market for their butter. In such localities it would probably be found profitable to establish dairy farms expressly for the manufacture of butter; but as this subject may be considered to belong more to agriculture than to manufactures, I will leave it by merely stating, on the authority of Dr. Ure, that butter is soonest produced from cream when its temperature is from 53° to 57°. If dairymen when churning were to take the trouble to ascertain the temperature with a common thermometer they might often save themselves several hours' vexatious delay by attempting to churn when the cream is either below 50° or above 60°; in this colony the latter will generally be the case. —*See* article on "Butter" in Appendix.

CANDLES.

No less than 1962 tons of candles were imported into Victoria in 1858, which were valued at £320,300; in the same year we exported 1016 tons of tallow, valued at about £44,000. We thus export tallow at about £43 per ton, and pay about £163 per ton for imported candles.* As I cannot tell the relative proportion of the different kinds imported, I cannot show what might be saved to the colony by the manufacture of any particular kind, but I will endeavor to show that no insuperable objection exists to the manufacture of the different kinds of candles now used in the colony.

Mould Candles.—On most stations and homesteads throughout the colony the common *mould* candles have been made, and are still made, simply because there is but little trouble attending their manufacture, and the material (ordinary house fat or tallow) is easily procured on the premises, and would otherwise probably be wasted or sold at about one-fourth of its value when made into candles. I have said there is but little trouble attending their manufacture, even in the very small scale attempted at stations and homesteads, where seldom more than two or three pounds are

* In 1859 we imported candles to the value of £215,796, and exported tallow to the value of £10,354, from which we may safely infer that the manufacture of candles in Victoria during 1859, greatly exceeded that of 1858.—C. Mayes, June 28, 1861.

made at one time by one set of moulds. It will be found that if made on a larger scale, as they might be by storing the fat or tallow for a few months, that the trouble would be materially reduced, and the candles might be made at the commencement and close of the winter in sufficient quantities for consumption during the year, instead of making small quantities, say monthly, in all weathers or temperatures, seasonable or unseasonable.

In 1858 there were thirteen candle manufactories in Victoria, three of which were in or near Melbourne. Both dip and mould candles are made here, but not *stearine* or any other superior or patent candles; these will probably be manufactured here in the course of a few years, as there is no great difficulty attending their manufacture, as I shall presently show. I have already referred to *home*-made mould candles, or mould candles made by amateurs at squatting and farm stations or homesteads. In making mould candles at candle-makers' establishments, eight or twelve moulds, according to size, are filled at one time, by being fixed in a frame like a stool; the tallow is supplied in a proper state for filling the moulds from an adjoining boiler, so that any number of frames may be filled as fast as the melted tallow can be drawn from the boiler. The time required to set the candles depends mainly on the temperature of the room in which they are moulded, but in cool weather about a quarter of an hour is sufficient. In England they have to be placed upon a table for inspection by the Excisemen; but in Victoria, they can be taken at once to the store, where, if kept for three or four months, they will become sufficiently whitened by age, and much better for use, than if used new after being bleached by exposure to the open air for a few days, which is sometimes done when a ready sale is desirable. Colonial mould candles have always obtained a good sale, as the number of candle manufactories will testify, notwithstanding the high price of labor, and this demand will increase as labor falls in value.†

Dip Candles are even more readily made than mould candles, and when we consider that only $1\frac{1}{2}$ per cent. in cost is all that is saved in obtaining a certain amount of light in the use of dip, as compared with mould candles (*See* "Candles," by Dr. Ure), we

† In 1859 there were eighteen soap and candle manufactories in Victoria.—C. Mayes.

must necessarily feel surprised that the slovenly, guttering, wasteful dip candles, made in the colony are tolerated. In Edinburgh a simple candle-dipping machine is in use by which one man can dip or make no less than 5000 candles in eight hours, in "moderately cold weather;" it necessarily follows that the item of labor, which in most manufactories is a considerable one, need scarcely be taken into account in making *dip* candles in cool weather.

Stearine Candles are made from saponified tallow or tallow converted into soap by an alkali, such as potash, soda, or lime, the last being generally used on account of its cheapness. The tallow and lime are boiled with water, and converted by this means into a kind of hard white soap, which is dissolved by oil of vitriol (sulphuric acid) when the stearic acid is brought to the surface as an oily substance; it is then drawn off, put into casks, and subjected to hydraulic pressure, which separates all impurities, leaving the stearic acid pure and white and fit for immediate conversion into candles; it is then cast in moulds the same as common candles, but the mould must be plunged into cold water to prevent crystallisation by too gradual cooling. This process, one would imagine, might be applied with advantage in cooling common mould candles in hot weather, the whole frame being lifted and plunged into a cold bath by means of a crane suitably fixed for the purpose. *Stearic acid*, or, as they are erroneously called, stearine candles can scarcely be distinguished from wax candles, which they are fast superseding. They are here known by the general name of patent candles, and are much sought after, 1Cd. per lb. being a common price charged for them, being at least double the price of common mould candles. The manufacture of soap and candles are often carried on together, since I perceive by the Melbourne Directory for 1860, that there are eight candle and soap makers in Melbourne and its environs. The only obstacles to the manufacture of *stearic acid* candles in Melbourne hitherto has been the high price of labor, and oil of vitriol, the latter of which would have to be imported for the purpose; the other two articles required we have in abundance, viz, tallow and lime. There certainly seems to be a favorable opening for an enterprising soap and candle maker to enter upon this branch of the trade, which has hitherto, as far as I can ascertain, never been attempted in this colony.

CARRIAGES, CARTS.

Under these heads we find imports in 1858 to the value of £55,000,* which I imagine includes all American vehicles, and likewise coaches, omnibuses, railway carriages, &c. The manufacture of these articles are rapidly progressing throughout the colony, our colonial woods being well adapted for this purpose; those principally used consist of blue and red gum, box, ironbark, blackwood, appletree, &c.—the blue gum, box, and blackwood being the three most valuable kinds of wood for these purposes. Railway carriages have been made here at a cost of about 20 per cent. more than those imported; this is due not to their cost in England, but to the expenses of shipment, damage on the voyage (to which this class of highly-finished carriages are particularly liable) and to the fact of their parts having to be put together, repaired, and re-finished in this colony. The Legislative Assembly having pledged itself to the manufacture in the colony of any railway carriages required for the Victorian railways, it is likely this particular branch of the trade will not stand still for the want of protection. Even so far back as 1854, "The Hotham Gig," made in the colony of native materials, by "Crothers and Hackett," was exhibited at the Exhibition in Melbourne; at the same time, Mr. E. Chambers exhibited a colonial-made "wrought-iron skeleton for a railway wheel." Since then every description of carriage, or vehicle, carts, wagons, and drays have been made not only equal to those imported, but, as a rule, far superior, and readily selling for at least one-half more: but this is owing more to the ignorance of the requirements of the colony than from any want of material or skill in England. Those elegant, light, and strong American buggies seem to be great favorites with the citizens of Melbourne, who naturally enough object to pay 40 or 50 per cent. more for a colonial substitute, the earnest cries of our coachbuilders for protection notwithstanding. On referring to the Melbourne Directory for 1860, I find no less than thirty-seven cart and wheel wrights in Melbourne and its neighborhood, and thirty-six coachbuilders. In 1858 there were also nine coachbuilders at Geelong.†

* In 1859 we imported carriages, carts, &c., to the value of £61,686, nearly two-thirds of which were from Boston and New York.—C. Mayes, June 28, 1861.

† In 1859 there were forty-eight coach factories in Victoria.

CEMENT AND LIME.

In 1858 we imported cement to the value of £11,200, at about 5s. per bushel. We also imported 3400 bushels of lime at the same price, and exported 12,000 bushels of lime at 1s. 10d. per bushel, here we have an anomaly requiring explanation; the common lime (as chalk lime) is sold in England at about 7d. per bushel, taking into consideration the difference in the price of labor, which is at least four times as great here as compared with England, lime of a good quality is cheap here, being only 1s. 6d. per bushel in Melbourne, or about two and a half times the price of ordinary lime in England; and from the facilities which exist in most parts of the colony for its manufacture, the price generally does not exceed this, the lime imported at 5s. per bushel must, therefore, be hydraulic lime. In treating of cement and lime it will be necessary to distinguish the two by showing the peculiarities of each. Common lime is produced by the calcination of carbonate of lime in the form of chalk, limestone, freestone (which is a pure limestone capable of being easily dressed or worked, and fit for building stone), and marble (a limestone sufficiently hard to be polished, and like chalk, consisting almost entirely of pure carbonate of lime). Lime made from these substances, and containing upwards of 95 per cent. of carbonate of lime, as the Heads lime for example, is only fit for building (in the form of mortar, plaster, or concrete), in situations not exposed to rain, and is not fit for drains, or culverts, cellars, tunnels, or hydraulic works—in fact, it can only be depended upon for durability when used in sheltered situations or for the inside of buildings. In all situations, continually or periodically exposed to the action of water, hydraulic lime must be used, which differs only from common lime in containing more than 5 per cent. of clay or alumina.

Hydraulic Lime and Cement.—A limestone containing 10 per cent. of alumina would make a good hydraulic lime; but an argillaceous limestone, containing 30 per cent. of alumina, would produce a strong hydraulic lime, which we should call cement. Portland and Roman cement are both strong hydraulic limes, and contain more than 30 per cent. of alumina, which causes them to set very readily; the time required for setting any kind of cement depends chiefly on the quantity of alumina it contains. Limestone is found in many parts of the colony; there is scarcely a county

in which it does not abound more or less. From the Blue-book I find there were ten limestone and 19 freestone quarries in Victoria in 1858,* which supplied 47 limekilns, 28 of which were in the county of Mornington, including the Heads, Western Port, and the S.E. coast of Hobson's Bay. The Geelong lime is slightly hydraulic, and that made on the Limestone Creek, between Mount Franklin and Guildford, is more so. There are doubtless other weak hydraulic limes made in the colony whose qualities have never been fairly tested, probably on account of their hydraulic properties being unsuspected by the proprietors. At the Melbourne University may be seen specimens of tertiary limestone obtained from at least nine different localities, many of which, judging from the appearance of the specimens would produce lime more or less hydraulic. Mr. Selwyn, our Government geologist, in his report of July, 1854, referring to the lowest bed in the tertiary formation on the eastern coast of Hobson's Bay, describes it as a "bed of stiff, blue clay, containing bands and septaria of hard, grey argillaceous limestone." Further on he says, "it is of excellent quality, and might be found highly valuable for making hydraulic cement. Calcareous nodules of a precisely similar nature are extensively collected for that purpose from the London clay, the cliffs of Hampshire, the Isle of Sheppey," &c.

Kilns.—Apart from the qualities of our limestones and cement stones, there is room for improvement in their calcination. There are two distinct kinds of kilns in use in England, viz., the "running" and the "flare" kiln. The "running" kiln is so called from the facilities it affords for running out the lime at the bottom, while the process of burning the chalk or limestone continues. This description of kiln is in the form of an inverted cone, and built where practicable on the side of a hill, the material and fuel being thrown into it in alternate layers. This is the kind of kiln generally used in this colony where wood is burnt instead of *breeze* or cinders, the common fuel used in England; but the "running" is considered inferior to the *flare* kiln in which the best kind of lime is always calcined; it is similar to the running kiln, but is

* As few people know the difference between freestone and sandstone, it is more than probable that the majority of the so-called freestone are really sandstone quarries, Victorian freestone being a very scarce article.—C. Mayes, June 25, 1861.

domed over, leaving a small chimney on the top to allow the smoke to escape; the chalk or limestone is built over the furnace forming a rough arch on which the bulk of the limestone rests, and which is supplied through an arched entrance left in the side of the kiln for the purpose of filling and emptying it. When filled this entrance is blocked up, and the kiln is fired from below in the same way that brick kilns are fired. The firing is kept up for about two days when the body of the kiln attains a white heat; it is then allowed to cool, and the lime withdrawn. The cost of lime burnt in this way is not more than 15 per cent. in excess of the mode pursued here, viz., by the "running" kiln, whereas the lime is fully 20 per cent. more valuable, being free from *core* and well burnt.

The importance of obtaining good lime induced the Victorian Contractors and Builders' Association to form a company for the manufacture of lime, the members of this association taking the largest amount of shares. By their prospectus they calculated on being able to make lime superior to that hitherto manufactured in the colony at about two-thirds the current price. It will be seen on reference to the commencement of this article that we exported 12,000 bushels of common colonial lime in 1858; while we imported hydraulic lime and cement to the value of nearly £20,000.

Artificial Cement.—If we have not sufficient natural cement stones to supply our wants we can at least make an artificial cement fully equal to any we import. All that is required is to mix ground limestone and clay in the proportion of 6 of the former to 1 or 2 of the latter, according to the quality of the cement or hydraulic lime required. This mixture, which should be well incorporated in a pugmill, may be either moulded by the same machine into cakes or bricks, and dried in *hacks;* or the mixture may be merely spread out into thin layers, dried, and broken up into fragments. There is less waste in the former method; and if the machine both tempers and moulds the cakes it is the best and cheapest. These artificial cement stones or cakes may be burnt in either a common *running* or *perpetual* kiln, or in a *flare* kiln, the latter being the best, as before stated, for lime.

Fuel for Kilns.—The quantity of wood required either for lime or cement kilns is about two cubic feet of wood to every bushel of lime or cement, which is equal to 200 cubic feet measured in the heap or *bolt* for every hundred bushels of lime. The manufacture

of cement in this colony is of more immediate importance than the manufacture of lime; we already produce more common lime than we require, seeing that we exported 12,000 bushels in 1858.

It is more than probable that this colony contains large quantities of cement stones or argillaceous limestone in beds or nodules fit for cement. In limestone localities are also found calcareous clays, which only require drying and burning to produce cement. "M. de Breislak thinks that it is to the happy union of *travertino* and *puozzolano* in the same spot that the monuments of Rome owe their great solidity." The manufacture of cheap cement, combined with the facilities of its transport throughout Great Britain, has almost superseded the use of *trass* and *puozzolano,* which used to be largely imported into England from Italy and other volcanic regions, to be mixed with lime and sand for hydraulic mortar.

This colony abounds with *travertino,* or a good substitute for it, in the recent limestone deposited by desiccated lakes or ancient streams, and also with *puozzolano,* or a substitute for it, in the calcined earth covering our basaltic plains; but as to whether the monuments of Melbourne 1000 years hence will owe their great solidity to this circumstance will depend not only on the wisdom of our engineers and architects, but also upon the enterprise of our colonial manufacturers. It is a well-known fact that imported cement is often more or less injured by a long sea voyage. There are also both public and private works erected in localities where cement would be too costly to be largely used if imported. In such localities it may sometimes happen that the very earth excavated from the site of the work for the basement or foundations of the building may consist of marl or argillaceous limestone, which might be burnt into cement on the spot, or such material might be obtained if properly sought for within a reasonable distance.

M. Vicat, the celebrated French engineer, during his lifetime saved to the French nation £7,000,000 in the manufacture of cement for their public works. When first employed by the French Government there were only seven or eight cement quarries in France; at his death there were between 700 and 800, and chiefly through his exertions in this direction France has become celebrated for her great hydraulic engineering works.*

Uses of Lime.—In addition to the use of lime for building pur-

* Civil Engineer and Architects Journal, vol. 9, p. 35.

poses, it is largely used in agriculture, not only in its pure state as a manure, but also as a deodoriser of night-soil, by which means one of the most valuable manures is obtained; it is also used in sugar-works, gas-works, soap and candle works; in bleaching linen and cotton, in fellmongeries and tanneries, in medicine, and in chemical researches.

Cement is used not only for building purposes but in the manufacture of *beton*, or hydraulic concrete, for vases, fountains, &c., as an artificial stone. *See* Article on "Cement," in Appendix.

CHARCOAL.

The uses to which charcoal is applied are numerous; those kinds containing silica are used for polishing metals; it is a bad conductor of heat, and is sometimes used to encase steam-pipes, and small furnaces. It is a most useful deodoriser for removing offensive smells from animal and vegetable substances, spirits distilled from bad grain, &c. (of which we have hundreds of thousands of gallons in bond—*see* "Brandy," page 274); in the construction of filters, both portable and upon a large scale, as for reservoirs, for which latter purpose it might be applied for filtering the impure water of the Yan Yean reservoir.* It is also used in the manufacture of the most durable ink, or black pigment. The ancients wrote with ink made from ground charcoal; and the writings found in the ruins of Herculaneum, more than 2000 years old, have retained their original blackness. Many other instances might be given of the indestructibility of charcoal, not only in ink or pigments, but also in the charred ends of stakes and piles.

Metallurgy.—By far the most useful and most extensive use to which charcoal ever has been applied is as a fuel in metallurgy. It has been used for smelting, or the reduction of iron ores, from the earliest records. Until the year 1740 it was the only fuel used in England for this purpose, and it was not until the dawn of the present century that coke and coal came into general use in England, not on account of their superiority to charcoal for the reduction of the iron ores, but more on account of the scarcity of wood in England, and the abundance and economy of coal: even now charcoal is used in England for the manufacture of some kinds of iron, and more especially in the conversion of charcoal

* This was written in July, 1860.—C. Mayes, June 26, 1861.

iron into steel, for which it is universally admitted to be superior to any other fuel.

Swedish Iron.—Swedish (which generally sells for about three times the price of English) iron, is always smelted with charcoal; it is also used for this purpose in France, and on the continent of Europe and Asia, the iron of Hindostan being similar to Swedish iron. Charcoal is superior to coke or coal for smelting iron because it contains no sulphur; the fumes of sulphur have a most injurious effect upon the iron it impregnates, and unless effectually eradicated, which is not always practicable, will cause latent flaws in castings; cast iron girders for brestsummers and bridges have been known to give way solely on that account; it is therefore very important that such iron should be fully tested before being used, and this is now usually done.

Tin Ores.—Charcoal is also generally used in the reduction of tin ores, and the manufacture of tin. As both iron ores and stream tin are among our raw materials, it is probable that charcoal will be extensively used in the manufacture of these metals, and more particularly in those localities where coal would be almost inaccessible, and charcoal plentiful and cheap.

Victorian Charcoal.—Neumann, who made many experiments on charcoal, informs us, that "for the reduction of the metallic oxides the charcoal of the *heavier woods* is preferable, and that for common fuel such charcoal gives the greatest heat." With a trifling exception, the whole of the timber of Victoria is both *hard* and *heavy wood*, generally heavier than water before it is dried and seasoned; in this respect at least we have an advantage.

The quantity of charcoal produced from different kinds of wood varies from 15 to 20 per cent.; the heavy woods do not always produce the largest quantity *but the best.* Charcoal like lime gains weight by exposure to the air. Messrs. Allen and Pepys found that by a week's exposure to the air the charcoal of six different kinds of wood they tried gained from 10 to 18 per cent. in weight.*

The facilities for the manufacture of charcoal in Victoria, where any quantity of wood can be obtained from the Crown lands on payment of a trifling license fee per annum, are only to be known to be acted upon. The charcoal hitherto supplied to founders,

* Dr. Ure.

plumbers, tinsmiths, &c., in Melbourne, is manufactured in a very imperfect manner from wood felled expressly for it, and burnt on a small scale, the pyroligneous acid, tar, &c., being wasted, the majority of the charcoal burners being unaware of its existence in all kinds of hard wood; they sell the charcoal in Melbourne at about 1s. 6d. per bushel, being equal to about one penny per pound, or wholesale, say £6 per ton.

Pyroligneous Acid.—If the manufacture of charcoal alone will pay, how much better return would it make were the pyroligneous acid, or wood vinegar, collected and sold to manufacturing chemists for re-distillation, &c., into acetic acid; it could even be re-distilled by the charcoal burner for wood-vinegar, since the process is simple and comparatively inexpensive.

Produce of Waste Timber.—The manufacture of these commodities in connection with the supply of sleepers for our railways, or with saw-mills, from the waste wood hitherto considered useless, is obvious.

I will endeavor, from a few calculations based upon well-established facts, to show the profits likely to arise from the production of sleepers, posts, and rails, or sawn hardwood of all kinds in conjunction with the manufacture of wood-vinegar, or acetic acid, and charcoal from the waste timber which would otherwise be left as useless, except in those few cases where it could be sold as firewood.

For the railway now being constructed between Melbourne and Sandhurst we require 3520 sleepers per mile, *i.e.* one per lineal yard for each line of rails, and for 100 miles (the distance between Melbourne and Sandhurst) no less than 352,000 hardwood sleepers will be required; each sleeper contains about four cubic feet, giving a total of 1,408,000 cubic feet of timber required for this railway in the form of sleepers for the permanent way. Our hardwood when about half seasoned would weigh about 56 lbs. per cubic foot, or 40 cubic feet per ton. In falling timber for sleepers, or for squared timber generally, at least one-third is wasted; this waste timber consists of the refuse from the trunk and the whole of the top of the tree: now 704,000 cubic feet at 40 feet per ton is equal to 17,600 tons. I have before shown that hardwoods produce from 15 to 20 per cent. of their weight in charcoal, and that they gain about 15 per cent. in weight by the absorption of moisture from the air during one week's

exposure; hence we may safely take the produce of charcoal from our hardwoods at 25 per cent., or one-fourth, therefore 17,600 tons of hardwood would be likely to produce about 4400 tons of charcoal, which, at £3 per ton (about half the price in Melbourne), would be worth £13,200. The best charcoal and the largest quantity of pyroligneous acid is produced from the *greenest* timber, or timber not long felled; all the small boughs and leaves will be consumed in firing the charcoal, which may be burnt in heaps or in kilns, the latter mode producing the largest quantity of liquid products. Stoltze has ascertained by numerous experiments that one pound of wood yields from six to seven and a half ounces of liquid products; hard timber which has grown slowly upon a dry soil gives the strongest vinegar. Charcoal burnt in a kiln, with a pipe to condense the vapors or fumes into a tank, yields about 25 per cent. of the weight of wood in liquid products, or crude wood vinegar.*

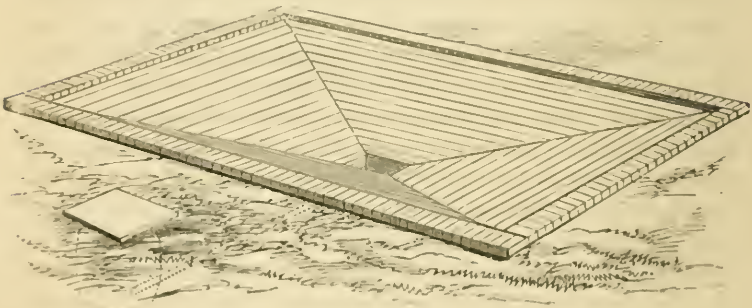
Clearing Land.—Another facility for the manufacture of charcoal is presented in clearing land for agricultural purposes, &c., and, in doing so, the timber has not only to be felled, but also to be sawn into portable logs, which are heaped together—for what?—not to be burnt into charcoal, worth at least £3 per ton, as fuel for foundries, &c., or to be used as a deodoriser when mixed with double its weight of night-soil, forming a most valuable and powerful manure; but to be consumed and cast to the winds, yielding comparatively little, in the form of potash, for the trouble of clearing and burning; whereas, by a slight increase in the expense required in splitting the largest logs, stacking them, and covering up the heaps with clay, sods, or the surface soil, they might be burnt into charcoal; should the land be heavy, clayey, or strong land, requiring burnt clay for manure, the advantage would be still greater, since the surface of it might be burnt by merely covering up the stacked heaps of wood to be converted into charcoal. Thousands of tons of hardwood have been destroyed in this way, merely to clear the land for agricultural purposes. To show that I have not overestimated the value of charcoal as a fuel, I will merely state, on the authority of Dr. Ure, that one pound of wood charcoal will raise 73lbs., of coke, 65lbs., and of pitcoal, 60lbs. of water from 32° to 212°. The relative heating properties of the most com-

* Dr. Ure.

mon fuels stand thus:—Perfectly dry wood, 35; wood in its ordinary state, 26; wood charcoal, 73; pitcoal, 60; coke, 65; turf, 30; turf charcoal, 64. In other words, for foundries, smithies, fuel for boilers, or the reduction of metallic ores, good hardwood charcoal will produce about 22 per cent. more heat than pitcoal, and about 12 per cent. more than coke by weight.

The price paid for the coke consumed on those portions of our Victorian railways now open for traffic cannot be far short of £7 per ton. Coals are now to be procured on the wharf in Melbourne at about £2 per ton wholesale. If consumed 100 miles inland, at least £5, or 1s. per ton per mile, must be added, making the total cost at Sandhurst, for instance, equal to £7 per ton.*

When it is considered desirable to save the liquid products of wood for the manufacture of acetic acid, wood tar, or creosote, in the absence of a kiln, earthenware pipes of 2 or 3 inches diameter may be inserted in the covering of the heap, and led into tanks, or small watertight vessels with moveable lids, which, with the joints of the pipes, must be luted with clay; the steam rising from the wood will pass through the tanks, being condensed in its passage. In addition to this contrivance, where a large quantity



of wood can be brought to one spot, it will be advisable to construct the heaps for burning upon a hopper-shaped hole, made in the ground and paved with bricks. "Into this space the tarry acid will partially fall, and may be conducted outwards by a small earthenware pipe into a covered brick tank," (or a cask, let into the ground, will answer the purpose equally well). A slab of

* This was written in August, 1860.—C. Mayes, June 26, 1861.

stone is placed over the tank or cask and an iron plate over the bottom of the hopper, to prevent the ashes getting into the earthenware pipe;* the whole will be best understood by reference to the annexed sketch, which represents everything required below the surface of the ground.

CREOSOTE.

See Pyroligneous Acid, under article Gas.

CORDAGE.

In 1858, we imported cordage to the value of £61,782, and twine to the amount of £12,892, together exceeding £74,000.† As cordage is produced chiefly by machinery, we may soon hope to manufacture it in Victoria. On referring to the article on Paper, in this essay, you will find that flax has been successfully cultivated on the Experimental Farm, near Melbourne, "and the fact that it will thrive well in this colony has been fully established." On reference to the Blue-book for 1858, I learn that, in 1858, four acres of flax was grown in the county of Grant.

Native flax is found in New Zealand in great abundance; it is the produce of the plant *Phormium tenax*, and the Government of New Zealand has offered premiums for its successful manufacture into a merchantable commodity. The *New Zealander*, of May 30th, 1860, stated that, "as far as they were aware, no claimant had hitherto demanded the premium;" but that Baron de Thierry has invented a process, by which the native material can be manufactured into an article equal to the celebrated and valuable article of export, "Riga flax."

In answer to an extract from the above article in the *New Zealander*, which was copied into the *Argus*, a letter appears from Mr. H. Christian, of Kew, to the effect "that he had already manufactured 16,000 halters in this colony chiefly from New Zealand flax, and that there was no more difficulty in making New Zealand flax a marketable commodity than there was in threshing a sheaf of wheat." As Mr. Christian states he has had 40 years' experience in the working of hemp and flax, his statement as to the value of the article should be considered conclusive.

* Dr Ure.

† In 1859 we imported cordage to the value of £59,246, and twine to the value of £8814.

GAS.

With one exception (which I shall hereafter refer to), gas has been manufactured in our Victorian gas works from imported coal, our own coal fields being, as it were, inaccessible, partly from the want of railways, and partly from the great expense of working them.

The Melbourne Gas and Coke Company was established in 1850, and in 1859, no less than 50 miles of main pipes were laid, supplying about 45 millions cubic feet of gas per annum; since then 40 miles of mains have been received, for the purpose of supplying Richmond, Prahran, St. Kilda, Emerald Hill, Sandridge, and North Melbourne: so that we may calculate that in 1861, at least 70 millions cubic feet will be consumed in Melbourne and its environs. In 1859, the price of the gas supplied to the public was 22s. 6d. per 1000 feet; it has since been reduced to 17s. 6d. per 1000 feet.*

In January, 1859, the Collingwood Gas Company issued a prospectus, wherein they stated that "it had been satisfactorily ascertained, from careful estimates of gas engineers, and from the *experience of colonial establishments*, that gas of high illuminating power can be manufactured from British and New South Wales coals at a cost of about ten shillings per 1000 cubic feet, inclusive of interest on capital;" and also that "it is anticipated that the company will be enabled to supply gas of pure quality at a price for the first year not exceeding fifteen shillings per 1000 cubic feet, and subsequently at a lower rate." These gas works are expected to be in operation towards the close of the present year (1860), and from the small outlay of capital, as compared with the Melbourne Gas Works, are likely to become a profitable undertaking, even at 15s. per 1000 cubic feet.†

The Ballaarat Gas Works yield about 300,000 cubic feet of gas per annum. There are also gas works at Geelong, Castlemaine

* By posting bills in Melbourne I find that the Melbourne Gas and Coke Company intend making a further general reduction to fifteen shillings per 1000 cubic feet, including the use of meters, after the 1st of July next.—C. Mayes, June 28, 1861.

† These gas works are now in full operation, and are producing gas at the rate of about 60,000 cubic feet per week, but will shortly be able to produce at least three times this quantity.—C. Mayes, June 28, 1861.

and Sandhurst, the gas being in each instance manufactured from imported coals. It is, therefore, not unlikely that, during the year 1861, no less than 90 millions cubic feet of gas will be consumed in Victoria, requiring about 10,000 tons of coal, from which about 6000 tons of coke, 1000 tons of ammoniacal liquor, and about 830 tons of tar may be produced. Hitherto, but little profit has accrued from these products to our Victorian gas works; they are valuable, and should, therefore, not be wasted, or unprofitably disposed of.* I will endeavor to show to what use they may be applied.

Coke is generally used for heating the retorts, about half the produce being consumed in this way, but as the coke is worth nearly as much per ton as coal, it is desirable to ascertain the practicability of heating the retorts with firewood. It would require about two and a half tons of ordinary firewood to produce heat equal in amount to that produced from one ton of coke. In many of our inland towns it may happen that coke would be worth from five to ten times its weight in firewood, and in such cases it would be most profitable to use the latter. In England coke is of sufficient value to render it profitable to make it from coal in coke ovens, in which all its volatile products are consumed. In Victoria it is not less valuable for locomotive engines, judging from its imported price, which is about £6 per ton.

In 1858 coke and fuel were imported to the value of £12,800; by fuel I imagine patent fuel is meant to be understood, the value of which is small compared with the coke. In the first six months of 1860 no less than 2150 tons of coke were imported, valued at £14,262, being about £6 12s. per ton; and 34,000 tons of coals, valued at about £1 16s. per ton. From which I am led to believe that coking, or the manufacture of coke from coal, in proper coke ovens, whereby the coals lose only 20 or 25 per cent. in weight, (without regard to its volatile products,) would pay well in Melbourne.

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* The Melbourne Gas and Coke Company in May last, advertised for tenders for the purchase of the tar manufactured at their Gas Works during three or five years, (at the option of the tenderers,) from the 30th inst. On the 19th inst. there was an advertisement in the *Argus* for a foreman of chemical works, acquainted with the manufacture of the products of tar and patent fuel.—C. Mayes, June 29, 1861.

Tar.—The next product to be considered in the distillation of coals is tar, and, as before mentioned, we may reasonably expect about 830 tons to be produced in 1861, which, at £10 per ton, would be worth £8300. Should we find little or no demand for coal tar it can be converted into oil and pitch, 830 tons of tar producing about 210 tons of oil, and about 400 tons of pitch. The patent kerosene oil now coming into general use in Melbourne, and its environs, is nothing more than distilled coal oil, which is sold at 8s. per gallon retail; reckoning the wholesale price at 6s. per gallon 210 tons of coal oil would be worth about £13,000; the pitch would be worth about £15 per ton, or £6000, which, with the coal oil, amounts to £19,000, being an increase on the value of the coal tar of £10,700, or nearly 60 per cent. for expenses of distillation, a considerable, if not the major portion of which £10,700 must be clear profit, over and above the original value of the tar * Should there be no demand at a remunerative price for either coal tar, coal oil, or pitch, the coal tar may be converted into gas, as shewn under *Olefiant gas* (which *see*); it will yield about three times as much gas as can be produced from an equal weight of coals similar to those from which it was obtained, and should, therefore, be worth at least three times the price of the coals per ton.

Ammoniacal Liquor, which is deposited with the tar in the tar tank, is most valuable as a liquid manure, and when diluted with four times its bulk of water becomes an invaluable top-dressing for grass lands, and for all other purposes to which guano and liquid manure are applied. Or it may be sold to the manufacturing chemists, who obtain about fourteen ounces of sulphate of ammonia from every gallon of liquor, and consequently from the 1000 tons before referred to about 110 tons of sulphate of ammonia may be obtained by saturating the solution with oil of vitriol, and

* These remarks apply more to a substitute for kerosene, sold as paraffine oil in Melbourne. The imported kerosene is either distilled from coal or from the petroleum or rock oil, which is obtained in great abundance from wells sank for the purpose, on Oil Creek, a branch of the Alleghany River, in Erie County, Pennsylvania; at Tidioute, in Warren County, further up the Alleghany; the eastern part of the State of Ohio; and from a large territory on the Thames River, in Canada West; the last locality yielding a supply almost fabulous. *See* "American Rock Oil," (from the *Times*,) in the *Argus* of the 28th of May last.—C. Mayes, June 29, 1861.

evaporating to dryness; in the same manner we may obtain sal ammoniac or muriate of ammonia by using muriatic instead of sulphuric acid. Carbonate, or sesqui-carbonate of ammonia is generally prepared by subliming in a retort a mixture of one and a half parts of clean dry chalk, and one part of sal ammoniac; it is used in medicine, and by confectioners, to give sponginess to their cakes by its volatization from the dough in the oven. Many patents have been taken out for manufacturing the different salts of ammonia from the ammoniacal liquor obtained from gas-works, among which that of Mr. Crolls stands pre-eminent, for purifying gas from ammonia (before it enters the lime purifier); this is effected by passing it through diluted sulphuric acid; this ingenious and valuable process not only purifies the gas, which would otherwise destroy the pipes, gas-fittings, gilding and metallic surfaces of ornamental apartments, but also yields a valuable product in the form of five pounds of sulphate of ammonia, which may be obtained from every gallon of the saturated solution of diluted sulphuric acid.* Its adoption is now becoming general in most gas works.

Coal Oil.—Dr. Ure states that "the coal oil, when rectified by distillation, is extensively employed for dissolving caoutchouc in making the varnish of waterproof cloth, and also for burning in a peculiar kind of lamp under the name of naphtha." It is sometimes used to advantage in *naphthalising* poor gas, by which the density and consequent brilliancy of the gas is increased; this is effected by merely passing the gas through the distilled coal oil before it enters the gasholder.

Cyanide of Ammonia is likewise obtained from the ammoniacal liquor, which may be converted into Prussian blue by saturation with muriatic or hydrochloric acid, and then adding sulphate of iron. According to M. Jacquemyns, the quantity of cyanogen and cyanates contained in twenty gallons of ammoniacal liquor is sufficient to form one ounce troy of Prussian blue. Cyanide of potassium and prussiate of potash are also obtained from the cyanates, but in such small quantities that it is doubtful, in the present state of the colony, whether they are of sufficient importance to engage the attention of manufacturing chemists.

Bitumen.—The value of coals for the manufacture of gas

* Dr. Ure.

depends upon the quantity of bitumen they contain, cannel coal being the best. Mr. N. W. Pollard, of the Railway Department, has obtained a patent in this colony for the manufacture of gas from Trinidad and other bitumens, and applying the residuum products to the manufacture of black varnish, or japan, and tar; the patentee informs me that Trinidad bitumen can be imported here, by the cargo, at about £6 per ton, and that from experiments he made at gas works in New York in 1851, he obtained no less than 27,000 cubic feet of gas from a ton of bitumen.

Olefiant Gas is more easily manufactured, and produces a more brilliant light than coal gas. It has been superseded by coal gas in Great Britain on account of the low price of coals and the high price of oils and fats as compared with their relative value in Victoria. Oil or liquid fat produces about 15 cubic feet of gas per lb., while cannel coal produces only 4, and ordinary coal from 2 to 3 cubic feet per lb.; olefiant gas, from its greater density, is worth at least twice as much per 1000 cubic feet as ordinary gas from inferior coal; the value of oil, fat, or tallow, when used for gas will consequently be about ten times the value of such coals per ton, and where the cartage exceeds £3 or the cost of the inferior coals delivered at the gas works exceeds £5 per ton, it will be found cheaper to use oil, liquid fat, or tallow, where either of them can be procured at about £40 per ton, which is likely to be above the cost in many parts of the colony, since the tallow exported in 1858 was valued at only £43, including the cartage from the bush.* The blubber and sediment of whale oil may be employed with advantage in the absence of good coal; this may occur in the neighborhood of whale fisheries, as at Portland and Twofold Bay. Two patents have been obtained in this colony for the manufacture of gas from oils and fatty substances, one of them by a Mr. John Hart, in December, 1858, who also lays claim to certain improvements in the construction and shape of the retorts used: the other patent was obtained by a Mr. J. T. Sanders, who claims the manufacture of gas from oil of resin, and other oils and fatty substances, the gas being purified in the retort before it passes into the condenser, and lastly in the general management of the necessary apparatus. "In England, the relative

* In 1859 the tallow exported from Victoria was valued at about £42 per ton.—C. Mayes, June 29, 1861.

cost of coal gas and oil gas may be estimated as one to six at least," as stated by Dr. Ure, who also adds, "Resin gas is cheaper than oil gas." The exceptions to this rule likely to arise in Victoria will be owing to the great cost of carriage; the coals in Melbourne being only £2 per ton, it follows that where coals cost £5 per ton in our inland towns, three-fifths of the cost will be for carriage; this is not the case with cannel coal, since it is worth about double the amount of ordinary coal, not only on account of its yielding a larger amount of gas, but also on account of the greater density and superior illuminating power of the gas obtained; therefore where cannel coal can be had for £10 per ton it will not be cheaper to make olefiant gas from tallow or waste fat even at £40 per ton.

Resin Gas.—The wholesale price of resin is about £12 per ton in Melbourne; and resin, according to Dr. Ure, will produce the same quantity of gas as can be produced from pitch, that is, about 10 cubic feet per lb., and will probably be found as valuable as coal-tar in producing an equal amount of light per ton; both resin and coal-tar may be considered to be worth about twice as much per ton as cannel coal so far as their gas-producing qualities are concerned: it follows, therefore, that at 120 miles from Melbourne, reckoning the carriage at one shilling per ton per mile, the cost of two tons of cannel coal at £3 per ton would be equal to the cost of one ton of resin or coal tar; therefore, if these materials have to be carted a greater distance than 120 miles, the two latter (*cæteris paribus*) will be the cheapest.

Portable Gas Apparatus.—Since writing the foregoing remarks upon the comparative cost of gas made from resin, tar, and coal, I have met with a pamphlet published by the Maryland Gas Company, of Baltimore, United States. This company manufactures portable gas apparatus for converting resin oil into olefiant gas; the apparatus is very simple and easily worked, and costs in Baltimore from about £70 for a complete apparatus, the gasholder of which contains 300 cubic feet, to about £200 for an apparatus with three retorts and a gasholder containing 1000 cubic feet; this apparatus is suitable for dwellings, churches, hotels, foundries, manufactories, &c. Other apparatus with four or more retorts and gasholders of any required size can be either made to order and imported from Baltimore or constructed in this colony under the sanction of the Victorian patentee before referred to, Mr. J. T.

Sanders. Mr. Ricards, sen., of the firm of Fisher, Ricards, and Co., of Melbourne, has a complete apparatus imported from Baltimore, which was temporarily erected between Spring street and the Parliament grounds about two years ago. He found it would not answer; that is, the gas would cost more in Melbourne than coal gas; this is also the case with gas made from tar, pitch, or oil, as I have before shown. The information contained in the above pamphlet is confirmed by some of the leading citizens of Maryland who have used the portable apparatus, and testify as to its superiority both in brilliancy and economy to either coal gas or oil lamps. From this pamphlet I also glean the following: "That a gallon of the resin oil will make from 75 to 100 cubic feet of gas of about twice the value in brilliancy as compared with common coal gas;" and, therefore, worth about 50 per cent. more than an equal quantity of cannel coal gas, from which I deduce the following estimate showing the comparative cost of cannel coal gas and resin oil gas, where the cartage of the material from Melbourne for producing the gas costs £4 per ton.

Resin Oil in Melbourne costs £19 per ton, and cartage £4 = £23 per ton, reckoning 80 cubic feet of gas per gallon: this is equal to about 20,000 cubic feet per ton, equal in light produced to 30,000 cubic feet of cannel coal gas. Against this we have cannel coal producing 10,000 cubic feet of gas per ton, which will require 3 tons for 30,000 cubic feet; cost of coal in Melbourne £12, and carriage £12=£24, showing a saving of £1 in favor of resin oil gas; I therefore conclude it is cheaper to use resin oil in any locality in Victoria where the cost of carriage is more than £4 per ton from Melbourne. The original outlay for the manufacture of resin oil gas would not in any case exceed one-half the cost of outlay for ordinary gas works, on account of the greater simplicity of the apparatus and the saving in main pipes, since several portable gas works could be maintained without materially increasing the comparative outlay. Against this, and in favor of coal gas works, we have the liquid products and one-half the coke, the other half being required for heating the retorts. Fuel is also required in heating the retorts in the resin-oil apparatus, but as only a low heat is necessary it can easily be maintained with firewood; and against this slight addition to the cost, as compared with coal gas, we may fairly set the great saving in attendance and the cost of purifying resin oil

gas, which is actually purer on leaving the retort than the coal gas of Victoria after passing through lime purifiers, no other means having, up to the present time, been adopted to free our coal gas from ammonia, although (as mentioned under the head of *Ammoniacal Liquor* in this Article) Croll's patent apparatus, which is most efficient for this purpose, has been successfully used in England for many years; the destructive effects of ammonia, and the consequent necessity for its removal from coal gas, I have before referred to.

Gas from Leaves, &c.—In October, 1857, Mr. G. W. Praagst obtained a patent in this colony "for obtaining, by distillation from the several varieties of gum leaves—first, a spirito oleaginous compound or crude oil; and secondly, carburetted hydrogen gas, pyroligneous acid and tar."

That portion of the patent relating to the distillation of carburetted hydrogen gas from gum leaves, was successfully carried into effect in the gas works of Kyneton, this township having been lighted with such gas for about two years.* From the information I have been able to obtain, it is superior in illuminating properties to the gas obtained from the Australian hardwoods, but inferior in this respect to the coal gas made in Melbourne, which is produced from a mixture of common with from 5 to 10 per cent. of cannel coal. The quantity obtained from a ton of gum leaves is from 9000 to 10,000 cubic feet, whereas, wood produces only from 4000 to 6000 cubic feet of gas per ton, and even this small quantity is poor in quality, consisting chiefly of hydrogen gas. It will not, therefore, of itself produce gas fit for ordinary uses, but might successfully be used in combination with olefiant gas, gas obtained from resin oil, or with cannel coal gas.

Gas from Wood and Coal.—In December, 1857, Mr. J. A. Huxtable obtained a patent in Victoria for the manufacture of gas from wood and coal. He claims the invention of the manufacture of illuminative gas by the "distillation of peat or wood con-

* I have since ascertained that the patentee was compelled to resort to the use of cannel coal at the Kyneton Gas Works, to bring the gum-leaf gas to the required standard; and ultimately, on account of the difficulty of obtaining gum-leaves, the gas was made wholly from cannel coal.—C. MAYES, June 29, 1861.

jointly with cannel coal, bituminous schist, or shale,* and natural bitumen."

This patent might be successfully carried out in supplying our inland towns with gas, the bitumen or natural asphalte (before referred to) being carted from Melbourne, and the wood found in the locality, used either in the same retort or in different retorts, the gas from each in equal volumes mixing in the gasholder, by which an average quality of gas might be obtained for probably 25 per cent. less than gas wholly from fat, resin oil, cannel coal, or bitumen.

Gas and Pyroligneous Acid.—There is an advantage attending the manufacture of gas from wood, if the crude vinegar can be collected and distilled into wood vinegar, or pyroligneous acid, which may easily be effected, and would prove more profitable than the distillation of wood for its charcoal and liquid products only. This will be better understood when we consider that wood is distilled in clay retorts for its produce in charcoal and wood vinegar, in the same manner that coal is distilled for gas, coke, tar, and ammoniacal liquor in our gas works; the chief difference consists in the larger size of the clay retorts, used for distilling woods. "In an establishment at Glasgow the retorts hold 8 cwt. of hardwood each—oak, ash, birch, and beech, being used. The heat of the retorts is kept up during the day, and the furnace is allowed to cool at night; the charcoal is then removed, and a new charge of wood introduced. The average product of crude vinegar or pyroligneous acid from the 8 cwt. of hardwood is 35 gallons, which is contaminated with tar; the charcoal left in the retort weighs about one-fifth of the wood used;† hence nearly half the weight of the wood is lost in incondensible gas, which might be purified in its way to a gasholder, there to be mixed with richer gas.

* A paper was read by Dr. Ralph, at the Royal Society of Victoria, on the 27th May last, upon a mineral called dysodile, from Tasmania, when it was shown to be a bituminous schist or shale, containing a large amount of microscopical algæ, coated with a resinous substance. Dr. Crook stated that a company had been already formed in Tasmania to extract the oil from the substance, and that the mineral was distilled in common iron retorts, and was likely to become an article of great commercial value.—C. Mayes, June 29, 1861.

† Dr Ure.

Pyroligneous acid is used in the arts for such purposes that it need not be highly purified. The quantity of sap or crude pyroligneous acid in red gum and other eucalyptii must be very great, since these hardwoods lose about one-third of their weight in seasoning. This acid in different woods also varies considerably in strength or acidity; that contained in red gum must be very strong, because if a saw is laid upon a fresh sawcut, it soon turns the saw black, showing the presence of a powerful acid on the surface.

Creosote and the real paraffine is obtained from the wood tar distilled with the crude vinegar. "It exists in the tar of beech woods to from 20 to 25 per cent., and in crude pyroligneous acid to the amount of $1\frac{1}{2}$ per cent."*

Acetic Acid.—"The crude acid is rectified by a second distillation in a copper still, leaving about 20 per cent. of tarry matter; it has now become a transparent brown vinegar, and its acid powers are 50 per cent. superior to household vinegar. By redistillation, saturation, evaporation, conversion, &c., a colorless strong vinegar is obtained, which is well known as the acetic acid of commerce," and is the vinegar used in large pickle manufactories, and imported here under the name of pale malt and white wine vinegar, with and without pickles, in large quantities.

Green hardwood timber is best for charcoal, and yields the largest quantity of wood vinegar.

Salts of Vinegar.—"When acetic acid is concentrated it becomes a very powerful scent, and is used in sickness and fainting fits. Salts of vinegar is sulphate of potash impregnated with acetic acid, and rendered aromatic with the oil of rosemary, lavender, &c., and is sometimes called "aromatic vinegar."*

GIN.

In 1858 we imported gin to the value of £108,268.†

The manufacture of *Hollands* or *Geneva*, as pursued in Schiedam is as follows:—Two parts by measure of unmalted rye, and one part of malted *bigg* (a light small grained kind of barley), are steeped together in a mash tun for about two hours, the water being added at about 165° Fahr.; the contents are vigorously

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* Dr. Ure.

† In 1859 we imported gin to the value of £109,992.

stirred and the mash tun closely covered up immediately after. After two hours steeping, the *transparent* spent wash of a previous mashing is then added with as much cold water as will reduce the whole to about 85° Fahr. Flanders yeast is then introduced to the amount of one pound for every 100 gallons of the mashed material. The fermentation occupies from 48 to 60 hours, when the wash is transferred to the still, and converted into *low wines;* to every 100 gallons of this liquor two pounds of juniper berries and a quarter pound of salt are added; the whole is then put into the low wine still, when the fine Hollands spirit is drawn off by a gentle and well-regulated heat." "The quantity of spirit varies from 18 to 21 gallons per quarter of grain," the spirit being 2 or 3 per cent. above proof, "this large product being partly due to the spent wash of the preceding fermentation, which also improves its flavor." The quantity of rye, and (bere or bigg) grown in Victoria during the year ending the 31st March, 1860, was 2714 bushels, showing an increase over the preceding year of 2063 bushels. I have no official information as to the use that is made of these cereals; but on referring to my article on "Brandy," it will be seen that illicit distillation is carried on to a large extent throughout the colony. Were distillation to be legalised, doubtless much of the £108,000 now annually spent for gin would be retained in the colony.

The preceding information on the manufacture of Hollands is abridged from Dr. Ure's article on gin, the details of which he obtained from a distiller who had studied the art at Schiedam, and who tried to bring it into general use in Great Britain, "but found the palates of our gin-drinkers too much corrupted to relish so pure a beverage." From this it is clear that Dr. Ure considers Hollands more wholesome than British gin, about which latter article he is ominously silent.

We already grow rye and bigg in Victoria. Juniper berries are grown here; they are not in request for this purpose, but would be if distillation was allowed by license at a low rate of duty per gallon, when we could compete successfully with the imported spirits, both as to quality and cost.

GLASS.

In 1858 we imported plate glass to the value of £12,213, and window glass valued at £16,450; since then the importation of

plate glass has greatly increased. In the first six months of 1860 we imported bottles to the value of £1850 (exclusive of those containing liquors, &c.) and glassware valued at £22,000; we may therefore safely take our annual importation of glass at not less than £60,000.* Without entering into the tedious details of the manufacture of glass, I will give a few recipes of the materials used in making certain kinds of glass, and then show that these materials are either among the raw materials of Victoria, or can be made from them, with one or two trifling exceptions.

"*Bottle Glass.*—Yellow or white sand, 100 parts; kelp (burnt seaweed), 30 to 40; lixiviated wood ashes, from 160 to 170 parts; fresh wood ashes, 30 to 40 parts; potter's clay, 80 to 100 parts; cullet or broken glass, 100. If basalt be used the proportion of kelp may be diminished."†

In the best bottle glass, as the *flask glass* of St. Etienne, some *heavy spar* or sulphate of barytes may be used, but only to the extent of about 1 per cent.; this last is the only article that need be imported for the manufacture of any kind of bottle glass.

"*Crown Glass.*—300 parts of fine sand; 200 of good soda-ash; 33 of lime; from 250 to 300 of broken glass; 60 of white sand (or crushed quartz); 30 of purified potash; 15 of saltpetre (1 of borax); $\frac{1}{2}$ of arsenious acid."†

The soda ash is crude carbonate of soda made from sea salt, and could be made from the saline deposit of our salt lakes; the potash is made from calcined vegetable matter such as thistles, straw, &c. (see Potash); saltpetre is a natural combination of potash and nitric acid, hence called nitrate of potash; the arsenious acid is obtained from various metallic ores found in Victoria, but as it only forms about $\frac{1}{1300}$ part of the materials used for crown glass, and about $\frac{1}{150}$ part of some kinds of crystal glass, it is an insignificant item in the manufacture of glass, and could be imported.

"*White Table Glass.*—100 of sand; 50 of purified potashes; 20 of chalk (or pure limestone); and 2 of saltpetre."

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* In 1859 the value of imported glass was, for bottles, £4,920; plate, £17,860; window, £22,895; and glassware, £23,522; total, £69,197.—C. Mayes, June 29, 1861.

† Dr. Ure.

"*Crystal or Flint Glass.*—60 parts purified potashes; 120 sand; 24 of chalk (carbonate of lime); 2 of saltpetre; 2 of arsenious acid; $\frac{1}{10}$ of manganese." Manganese (oxide of) has been found associated with the lithographic limestone of Geelong.

Another *Crystal Glass* which is fit for optical and chemical purposes, is made with "120 white sand (or quartz); 40 of purified pearlash; 35 of red lead; 13 of saltpetre; $\frac{1}{12}$ of manganese."* Pearlash, like potash, is a preparation of calcined vegetable matter. Red lead or minium is prepared by calcining common lead with a slow fire, lixiviating it, &c.

"*Plate Glass.*—Very white sand (crushed milk-white quartz), 300 parts; purified soda, 100 parts; carbonate of lime (pure limestone), 43 parts; manganese, 1; cullet or broken plate glass, 300."* These are the materials used for mirror plate glass on the Continent of Europe, the purified soda is *carbonate of soda* (see article on "Soda.") There are other kinds of glass, such as *green window, or broad glass*, the common *dark green bottle glass, &c.*, the last two being cheap inferior glasses. An improved *broad or spread window glass* is made in Birmingham, &c., under the name of *British or German plate* glass. *Chance's British sheet* glass is made in the same way, but with the materials used for crown glass.

Kelp and Soda Ash.—Kelp, or calcined seaweed, which used to be largely used in the manufacture of glass, is now superseded by the economical manufacture of carbonate of soda and soda ash from sea salt, which from its well known invariable properties, can be safely depended upon, whereas kelp, from its variable constituents, was too often a source of annoyance and loss to the glass manufacturer.*

Saltpetre or *nitre*, one of the materials used in making crown, crystal, or flint and plate glass, could be made here from *nitre beds*, as practised in Sweden and France (2000 tons fit for the manufacture of gunpowder were annually made in France during the wars of the Revolution); but as it is a natural efflorescence from porous stones and the surface of the ground in certain parts of Spain, Egypt, India, &c., it could always be imported much cheaper than it could be made, the three last named countries generating sufficient for the wants of the whole civilized

* Dr. Ure.

world, since it almost unaccountably re-appears annually after the surface of the ground, stones, &c., has been carefully cleared of the previous crop.*

Endigenous Materials.—It will be seen from the foregoing remarks that in materials for glass making we are not inferior to any other civilized country in the world, since we possess inexhaustible supplies of fine white sand or quartz, the principal material of glass, and can either manufacture or import all other necessary materials. It is to be hoped that the time is not far distant when the pure white sand of our beaches and the milk-white crushed quartz of our gold-fields will be sought for this purpose. I recollect reading many years ago that the sea-sand on the coast of Gipps Land was unsurpassed for its purity and whiteness by any other sand for the manufacture of the best kinds of glass, and that it had been imported into England for that purpose.

Furnaces.—In the construction of the furnaces, which seldom last more than twelve months, and therefore form an important item in the current expenses of glass making, fire-bricks are required made from equal portions of silica and alumina, or pure quartz sand and washed clay, as described under "Brick Earth," in the article "Bricks" (which see).

Fire Clay.—The melting pots are also made from a superior kind of fire clay, mixed with broken pots or crucibles, as shown under "Pottery" (which see).

Slip.—Instead of lime or cement mortar (which is fusible), a fire-mortar is used called *slip*, which is made from the constituents of fire-clay, ground, washed, and properly mixed by passing it through a hair sieve; this mixture is used to connect the fire-bricks, and as a substitute for mortar in the furnaces.

Polishing and *Grinding* plate glass is done by machinery, the last or finishing polish being the work of females in France, "who slide one plate over another while a little moistened putty of tin finely levigated is thrown between."†

Silvering Plane Mirrors "consists in applying a layer of tinfoil alloyed with mercury to one surface."† This process is now carried on in Melbourne, by Messrs. Ramsay Bros., where a mirror 10 feet by 7 feet has lately been silvered, and is described in the

* See article on Glass, by Dr. Ure. † Dr. Ure.

Argus (about August 5, 1860). The tinfoil, which is rather larger than the glass, is covered with mercury and amalgamated with it by rubbing the mercury over the tinfoil; the glass is then slid on to the tinfoil, the mercury being pushed before it; it is then pressed down by a large number of covered weights, which remain upon the glass for about thirty-six hours. This process differs little from that described by Dr. Ure, who, however, states that about a month is required for draining out the superfluous mercury from large mirrors, and from eighteen to twenty days from those of moderate size.

Fuel.—In regard to the kinds of fuel used in the furnaces, Dr. Ure says: "Formerly wood fuel alone was employed for heating the melting furnaces of the mirror-plate manufactory of St. Gobin; but within these few years, the director of the works makes use with nearly equal advantage of pit-coal. In the same establishment two melting furnaces may be seen, one of which is fired with wood, and the other with coals, without any difference being perceptible in the quality of the glass furnished by either." * * * "The construction of the furnaces in which coal is burned is the same as that with wood, with slight modifications. Instead of the close-bottomed hearth of the wood furnace, there is an iron grate in the coal-hearth through which the air enters, and the waste ashes descend."

"When billets of wood were used as fuel they were well dried beforehand, by being placed a few days on a framework of wood called the wheel, placed two feet above the furnace and its arches, and supported on four pillars at some distance from the angles of the building."

There are many localities where glass might be made with advantage, such as a white sandy beach accessible by small vessels, and having plenty of wood or coal in the neighborhood; also, on the banks of our salt lakes, supposing the sand to be suitable, fuel near, and the locality easy of access; all these prerequisites are probably attainable.

In these two supposed localities the soda could be made on the spot from the sea water of the beach, or salt found on the banks of our salt lakes. Should it be deemed unadvisable to manufacture the soda, the other ingredients, sand and fuel, might be obtained in hundreds of places in the colony, and even quartz-crushing for gold and sand carried on simultaneously.

GLUE.

In 1858 we imported 20 tons of glue, valued at £2030, or about £101 per ton.* Glue is the substance gelatine in a dry state, and is prepared from the parings of ox, horse, and other thick hides, and the refuse of the leather dresser, which afford 50 per cent. of their weight in glue. The tendons and similar offal of slaughter-houses also afford materials for glue, but it is inferior to that made from those first named. Skin of any kind, if uncombined with tannin, will make glue; the tannin is inseparable from the glue by any known chemical process, and this is why leather cannot be made into glue. The skins must be thoroughly cleansed before being used for this purpose by macerating in milk of lime. They are then, with other animal matters, boiled in a copper, with a false bottom to prevent the glue from burning; after being boiled for a certain time, the jelly formed in the bottom of the copper is drawn off by a stop cock; the first boiling is always the best, the second and third being weaker, and are again used for boiling fresh animal matter; the jelly, after being drawn off for glue, is kept hot for five hours to settle, the clear solution being then drawn off into casting boxes, which remain all night, when they are turned out on to tables, cut up into the required form, and suspended in nets to dry; if the weather is too damp for this purpose, the glue is dried upon hurdles in a drying-room, heated with a stove. "The pale colored, hard, and solid glue, made from the parings of ox or horse hides by the first boiling is the best and most cohesive."†

In 1858, we exported 166,811 skins, besides 311,013 horns and hoofs; there were also fifty-eight fellmongeries and tanneries in the colony at the same time;‡ from these combined sources it is probable there was ample waste material for at least 20 tons of glue, the quantity imported in 1858.

The Victoria Glue Company now have works at Sandridge.

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* In 1859 we imported glue to the value of £3534, showing an increase as compared with 1858.—C. Mayes, June 29, 1861.

† Dr. Ure.

‡ In 1859 we exported 251,293 skins, and 295,503 horns and hoofs, weighing 28 tons 12 cwt.; at the same time there were 20 fellmongeries and 31 tanneries in Victoria.—C. Mayes, June 29, 1861.

HATS AND CAPS.

These articles of apparel were imported here in 1858, to the value of £85,173, but during the first six months of the present year, 1860, the importation has fallen to £32,000, as compared with £42,000, the amount for the corresponding period of 1859.*

"The materials used in making stuff hats are the *furs of hares and rabbits freed from the long hair*, together with wool and beaver."† We have but few rabbits in the colony; but, as a substitute, we have a large number of opossums and kangaroos, wallabys, wombats, &c., whose furs might be applied to hat making, the long hair being used for the manufacture of felt for this and other purposes.

The skeletons or shells of stuff hats are made of whalebone, horsehair, paper, &c., which are washed over or saturated with a waterproof composition; the nap is then worked on to the shell by being dipped into a hot *liquor* and rolled. There are many operations connected with hat-making which would be too tedious to describe; but most of them can be effected by machinery, such as separating the nap from the long hairs by a kind of winnowing machine; machines may also be had for making the shells, ironing the hats, *roughing* or working the nap on to the shell or skeleton of the hat, &c.

With the exception of silk and beaver, we have all the materials required for hat-making; these are whalebone, wool, and horsehair, and the furs of animals, as abovementioned, which are also suitable for the manufacture of felt, either for hats and caps, or for other purposes to which felt is applied, as for roofing, coating, boilers of engines, as a non-conductor of sound between partitions of cabins, &c.; for these latter purposes the hair of oxen, horses, &c., is also made into felt. Every imported hat costs 3s. for freight, cases, insurance, &c., which would be saved if they were made here.‡

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* In 1859 we imported hats and caps to the value of £86,153.

† Dr. Ure.

‡ From the evidence given before the Tariff Committee, in March, 1860, I abstract the following:—"There are from 100 to 150 journeymen hatters in Melbourne, and only about 12 employed at their trade;—that a man can make 18 black silk, felt, or shell hats in a week, for which he would be paid from £3 to £3 12s." That imported hats are inferior to those made in

Straw Hats and Bonnets.—In the list of imports for 1858, no mention is made of bonnets, which are probably included under drapery. The number of Italian or Leghorn, Tuscany, and English straw bonnets imported here must be considerable, if we consider that only a portion of our population, say 50,000 females, were to require even one straw bonnet during the year, at an average value of 10s. each, it would amount to £25,000. That this estimate is rather below than above the mark will be apparent, since English straw bonnets vary from 5s. to 20s., and Leghorn (worn by ladies) from £1 to £4 each. It is this very expensive kind of bonnets, the straw for which is exported from Tuscany and other parts of Italy into England, and there woven or plaited and sewn for bonnets, which we might probably grow and manufacture in Victoria. It appears, from the account given by Dr. Ure, that the Italian and Tuscan straw is made or prepared from the bearded wheat, which is pulled up while the ear is in a soft milky state, and spread out in the sun for three or four days to dry; it is then tied up into sheaves and stacked for about a month, when it is removed to a paddock and again spread out to be bleached by the aid of the sun, air, and dew; the roots and the lower joint of the straw is then separated from the stem, leaving the upper part fit for use; it is then sorted according to quality, steamed for the purpose of extracting its color, and submitted to the fumes of sulphur to complete the bleaching. In this state, (the dried ears of wheat being still on the straw), it is imported into England to be split and dyed, the Leghorn being then generally woven, and the Tuscan plaited and sewn. The valuable properties of this straw may be chiefly due to the climate of Leghorn or Italy, which resembles that of Victoria.

HORNWARE.

The horn of oxen, cows, goats, sheep, &c., is a tough, semi-transparent substance, which can be pressed into a variety of forms required for combs, rings, handles for knives and forks, &c. The best process is to boil the horn after being sawn in two, longitudi-

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Victoria because they are injured in transit by the dampness of the salt water. That, supposing we could compete with imported hats, nearly as many females as men might be employed.—C. Mayes, June 29, 1861.

nally, and press out the leaves, or sheets, by iron vices; these pieces are then sawn to the required thickness, if for sheets or plates, which may be joined together, by being first fixed in an iron mould, and, while so fixed, plunged into boiling water till the edges are softened, when they are joined and plunged into cold water, the edges being thus perfectly united; horn can be spotted to imitate tortoise-shell by a simple process. Cutting the teeth of combs is accomplished either by hand or by machinery; one of the machines used resembles a lathe fixed with fine circular saws at the requisite distance apart to cut the whole of the teeth simultaneously, the plate, or intended comb, being pressed against the saws for that purpose; another machine, invented by a Mr. Lyne, cuts two combs at once by means of chisels, which prevent any waste of material as in sawing. "The kind of horn most preferred is that of goats and sheep, from its being whiter and more transparent than the horn of any other animals." "Bullocks horns may be softened by roasting in the flame of a wood fire, when they are split up and pressed as before stated." * Without entering into the details of the process of manufacturing rings, handles for knives and forks, knobs for handles of furniture, powder-horns, drinking-horns, snuff-boxes, &c., it may be sufficient to call attention to the fact that in 1858 we exported 311,000 horns and hoofs, valued at £6150; many of the above articles are either turned or made by machinery, so that their cost does not altogether depend upon the value of skilled labor.

IRON.

In 1858 we imported rod and bar iron to the value of £58,942; hoop iron, £2431; iron wire, £12,630.†

Iron Ores of Victoria.—Hitherto iron has not been obtained from the ores of the colony, although they are found associated with coal, fire-clay, and limestone at Western Port, Cape Paterson, and other Victorian coal-fields.

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* Dr. Ure.

† In 1859 the value of imported iron was as follows:—Rod and bar iron, £83,981; castings, £6089; galvanised, £85,917; galvanised wire, £3956; hoop iron, £2944; pig (cast iron), £20,485; pipes, £32,055; sheet, £9422; wire, £20,676; undescribed, £3559; railway materials (chiefly iron), £95,830. together equal to £364,914.—C. MAYES, June 29, 1861.

Hæmatite.—The most valuable ores in this or any other part of the world are the red and brown hæmatites, which generally contain about 66 per cent. of pure iron, being about double the per-centage of the carbonates from which nearly the whole of the iron of England is obtained. Hæmatite is found in large quantities in many parts of Victoria, as at Western Port and throughout our numerous and extensive gold-fields, where it generally encases the quartz reefs or veins of the palæozoic or auriferous strata. Titaniferous iron-sand is found in abundance on the eastern coast of Port Phillip Bay, on the coast of Cape Liptrap, and many other places where the tertiary formation occurs. Its commercial value is, however, inferior to hæmatite, unless it is of that kind which is attracted by the magnet, when it partakes more of the nature of magnetic iron ore from which the celebrated Dannemora, or best Swedish iron is made. The ferruginous sandstones found on the east side of the Bay contain nodules of ironstone as rich in iron as hæmatite; a specimen assayed by Mr. Davey, gave 67 per cent. of iron, and a very little titanium.

Facilities.—We possess, then, fire-clay for the manufacture of fire-bricks, indispensable in the construction of cupolas, or smelting-furnaces; iron ore, with the coal for fuel; and limestone for a flux to assist the reduction, or smelting process; and these materials are generally associated in the coal-fields of Victoria. Independently of this source of iron we have, associated with hæmatitic iron ore, immense quantities of hardwood timber, which is easily converted into the best description of charcoal for smelting purposes; in many such localities may also be obtained suitable limestone for a flux; * fire-clay fit for fire-bricks to construct the cupola, the same clay being a refractory substitute for the mortar, called *slip*, used for the joints of the brick lining; and, lastly, clean silicious sand for moulding.

Iron ores of England.—Previous to 1740 the brown and red hæmatites and the earthy iron ores of England were smelted

* As valuable iron ores are found contiguous or associated with basalt, in many parts of Victoria, where limestone cannot be easily obtained, it would be well worth our while to ascertain by actual trial the value of basalt as a flux for reducing iron ore; it has been long used for this purpose for smelting copper. Basalt and rich iron ore are found associated on Batman's Hill, Melbourne.—June 29, 1861.

entirely with charcoal; but it does not appear that the clay iron ores of the coal measures were then used, although they are the chief source of British iron at the present day. In 1796 the process of smelting with charcoal was almost given up in consequence not only of the scarcity of wood fuel in England, but also on account of suitable iron ore being discovered and obtained from the pits that furnished the coal; from which favorable continuity of iron ore and coal England owes much of her present wealth and wide-spread commerce.

Smelting with Coke.—As before stated, we have a similar combination in our Victorian coal-fields to that last mentioned, and where such localities are near to good shipping places, or have a market within a reasonable distance, it is highly probable that smelting with coke would be found remunerative. Such iron would be softer and more suitable for castings than charcoal iron, although for most other purposes inferior to it.

The iron ore would require to be roasted before being smelted, which could be easily accomplished in the same manner that quartz is roasted on our gold-fields before being crushed, that is by being piled upon a heap of wood, which is fired and allowed to burn out; if the saving of wood fuel should be deemed advisable the ores could be more economically roasted in *running-kilns*. (*See* "Kilns," in article "Cement and Lime.")

Smelting in England.—The blast furnaces of Staffordshire are constructed almost wholly of bricks, the sides of the cupola being bound with a great many iron hoops, by which a great saving is effected in the thickness of the walls. In South Wales the furnaces are much slighter than those of Staffordshire, and are also higher in proportion to their diameter; they are used chiefly for refining the cast iron preparatory to its conversion into bar and rod iron, boiler-plate, &c., while those of Staffordshire are used chiefly for castings. These furnaces will last from three to seven years without repairs to the lining of the lower part of the furnace, the upper part of the lining lasting much longer.

The consumption of coal per ton of cast iron varies from three to four tons; the quantity of limestone required as a flux is about one-third the weight of unroasted ore (carbonate of iron), which yields about one-third of its weight of pure iron, therefore the quantity of limestone required is about equal in weight to the

iron produced from carbonate of iron, or clay ironstone, the kind of iron ore generally found in combination with coal.*

The blast of air supplied to blast furnaces is produced by the rapid revolution of a fan enclosed in a box open on one side to admit the air, which is propelled from the circular case, or box, into a pipe leading to the hearth, or crucible, of the furnace; this pipe may supply any number of branch pipes with compressed air, and any of these may be heated by furnaces before entering the tuyeres, or blowpipes, of the blast furnace.

Hot blast.—The hot blast is generally supplied at from 612° to 662° Fahr., and produces about 50 per cent. more iron in a given time, with the same amount of fuel. The coal is always carbonized, or converted into coke (before being used for smelting, or refining, iron), by which means most of the sulphur in the coals is driven off which would otherwise materially deteriorate the quality of the iron.

Although the quantity of iron produced in a given time, from the same amount of fuel, is so much in favor of the hot blast over the cold blast furnace, even to the extent of 50 per cent., (or, to put it in another form, one-third of the fuel may be saved by using the hot blast,) and, although a much greater heat can be obtained, by which means finer and thinner castings may be made, it seems strange it has not come into general use in Victoria, where the saving in fuel, one would imagine, would be of almost paramount importance. I am not aware of even one foundry in the colony where the hot blast is used; it may be on account of the additional outlay in capital required to construct the air-heating furnaces.

The *finery furnace*, or *running-out fire*, is a smelting hearth, in which, by first fusing, and then cooling, crude cast iron, it is converted into *fine iron*, for making malleable iron by *puddling*.

"Whatever care is taken in the process of fining, the bar or plate iron finally resulting is never so good as if charcoal had been used in the refinery." *

The *puddling* furnace is of the *reverberatory* form. In this furnace the fine iron, prepared by the refinery furnace, is *puddled* or worked about with a rake, by which process the oxyde of carbon is disengaged from the iron, which is worked up into balls, to be afterwards forged or beat out, and then rolled into sheet, plate, bar,

* Dr. Ure.

or rod iron, as required, by the aid of powerful machinery. "The puddling process lasts from two to two and a half hours, and is attended with a loss of iron of from 8 to 10 per cent., even when skilfully manipulated. In Wales the consumption of coal is equal in weight to the fine metal puddled. About five puddling furnaces are required for the service of one smelting furnace and one finery."*

The forge hearth is employed for working up *scrap* into boiler plate, sheet, bar and rod iron, &c.: as before stated, wood charcoal is the best fuel for this purpose. "About 22 bushels, or 4 cwt. of charcoal are consumed in making one ton of iron of this description, from boiler-plate parings."*

Swedish bar, imported into England at about three times the price of English iron, where it is used chiefly for conversion into the best cast steel, is made from hæmatite, smelted, refined, and puddled, with charcoal fuel. In Sweden it yields only 47 per cent. of cast iron, with a consumption of 130 per cent., by weight of charcoal, as compared with the weight of cast iron produced.

The furnace used to produce so small a per centage of iron, from hæmatite, with so inadequate an expenditure of fuel, is elliptical, 30 feet high, and 8 feet smallest diameter, and is worked with forge-bellows, mounted with leather. Were proper hot blast furnaces to be used, the results should not fall short of the blast furnaces of Staffordshire or Wales; the force or pressure of the fan blast would require to be modified, to prevent the charcoal being blown out of the furnace, or some other, and perhaps more efficacious method could be arrived at by actual experiment to attain this desirable result.

Charcoal Iron, the best Iron.—The most valuable iron is made from hæmatitic iron ores, smelted, refined, and puddled, with charcoal, and bar iron, made in this manner, is the best iron for conversion into all kinds of steel. I have before shown that we possess hæmatitic iron ores in abundance, often in contiguity with hardwood, which is easily converted into excellent charcoal, so that it is possible to make the best iron and steel in such localities, but we must invent some more efficient process than that pursued in Sweden, where only one cwt. of cast iron is produced for each ton obtained from a blast furnace of the same size in Staffordshire or

* Dr. Ure.

Wales. This great difference is due chiefly to the absence of the blast fan in the Swedish furnace before referred to, and the small quantity of charcoal used for each ton of iron produced.

Victorian Iron.—The forging of a horse-shoe is considered to be a good test of the quality of iron. At the Melbourne Exhibition of 1851, a specimen of native iron was exhibited from Western Port, and a horse-shoe made from it, superior in density and texture, to the generality of horse-shoes, so far as I could judge from a casual inspection. A large specimen of native iron from the same place, is now (September 1st, 1860), to be seen in Mr. Norton's shop-window, in Collins-street east.

Iron-rolling mills have been recently opened in West Melbourne, for the manufacture of bar and rod iron, from ¼ inch square or round, up to 2½ inches. The material used is old or scrap iron, which is cut to the proper length and made up into fagots of about 30 lbs. each. They are then subjected to the furnace, from a half to three-quarters of an hour, drawn out in fused masses, and rolled into bar or rod iron. The fuel used is coal, and the iron produced is at least equal, if not superior, to that imported. Several specimens of bar and rod iron, from this manufactory, were submitted to the Royal Society of Victoria, but it is only from actual experiment that the peculiar characteristics of iron can be ascertained with certainty. It is well known that coal, as a fuel, renders the iron softer and more ductile than the same iron would be, if prepared or manufactured with hardwood charcoal. If it should be deemed advisable to convert the waste iron of the colony into sheet or plate iron, or into bar iron, to be afterwards made into steel, hardwood charcoal would be found to be the best fuel for the purpose, although in Melbourne it would cost about double the price of coal, or at least £4 per ton, although on many of the gold-fields it is made for about 50s. per ton.

Natural Steel may be produced in the conversion of cast into wrought iron, by a slight difference in the working; this may be more readily understood, when we consider that steel is merely carbonised iron, and that cast iron, which generally contains more carbon than steel contains, is deprived of its carbon in refining and puddling, the process employed for its conversion into wrought iron. "In Sweden, the cast iron pigs are heated to a cherry-red, and in this state broken to pieces, under the hammer, before they are exposed to the steel furnace. These natural steels are much

employed, on the continent of Europe, in making agricultural implements, on account of their cheapness. Natural steel is made in large quantities at the celebrated steel iron works of Upper Silesia, in Germany. The natural steel of Styria is also regarded as a very good article. Wootz is a natural steel prepared from a black iron ore in Hindostan; it is smelted with charcoal, in a small clay furnace, with hand-bellows." *

Hæmatitic Iron.—" In 1837 Mr. N. W. Clay obtained a patent for improvements in smelting and refining hæmatitic iron ores. He mixes bruised hæmatite with 20 per cent. by weight of clean carbonaceous matter, in coarse powder (this may be charcoal, coke or coal dust), and subjects this mixture, in a ∪ shaped retort, to a bright red heat for at least twelve hours; the metal is then transferred into a puddling furnace. In his second patent, in 1840, Mr. Clay prescribes from 30 to 40 per cent. of carbonaceous matter to be mixed with the ground or crushed iron ore, which mixture is to be directly treated in a puddling furnace." * By this last method the fine iron is produced, at one operation, from the crushed iron ore, without a smelting furnace. Such a method of obtaining refined iron fit for immediate conversion into malleable iron, in the shape of rod, bar, plate, or sheet iron, is well worth a trial on our gold-fields, where hæmatitic iron ores are generally found encasing and permeating our quartz reefs. Even the iron cement of our gold-fields might be found profitable to convert either into cast or malleable iron, where both charcoal and limestone are easily obtained. It is not necessary that a large outlay should be made to construct iron works or foundries for the purpose of trial. The process of reducing iron ores, either into cast iron or natural steel, is so simple, that two men with fire-clay, hæmatite, or other rich iron ore, charcoal, limestone, and a forge-bellows at hand, could construct a fire-clay cupola or furnace, prepare and smelt, say one cwt. of cast iron in about two days, and could reconvert this iron into steel, in the same furnace, in a few hours.

Hindoo Iron and Steel.—All that is necessary to convert iron into steel is to make several refractory or fire-clay retorts, into which "the cast iron is placed in small pieces, mixed with charcoal powder in the retorts, which are placed in the small blast furnace, kept covered with charcoal, and subjected to heat urged

* Dr. Ure.

by the blast of the forge-bellows for about three hours. The crucibles or retorts are then taken out of the furnace and broken, when the steel is found in the form of a cake in the bottom of the crucible."* This is the system pursued by the natives of Hindostan for obtaining iron and steel, only they have no proper forge-bellows, but merely a goat's skin with bamboo nozzle and handles, which must be a miserable substitute for proper forge-bellows. Then, again, instead of putting several pounds of iron into each crucible with powdered charcoal, they seldom put more than one pound, the retort being filled up with dried chopped wood; yet, with such rude materials and miserable appliances, the best cakes of Indian steel, when remelted and tilted, or hammered into rods, are stated, by a very competent judge, to be "superior to the best English cast steel for fine cutlery."*

I am credibly informed by a gentleman, long resident at Pleasant Creek gold-fields, in the Ararat district, that cast iron basins for quartz-crushing, weighing about three cwt. each, are sold there for £12 each; similar cast iron basins could be obtained in England for about 30s., and could be made on our gold-fields probably for about £3 each. It is more than probable that in every locality throughout the colony, where the cartage from Melbourne exceeds say £5 per ton, and where fire-clay or any kinds of refractory clay, rich iron ore, limestone, and charcoal are at hand, that all kinds of iron and steel could be manufactured equal in quality to and at the price of that imported.

Nails are made by machinery, with but very little assistance of the human hand. It is in such manufactures, requiring little manual labor in their production, that we can most easily compete with imported articles, since the cost and working expenses of machinery, as compared with manual labor, are smaller here than in Britain, America, &c.

So far back as 1810 the Americans possessed a nail machine that could turn out 100 nails per minute, cut and headed at one operation. The manufacture of cut nails by machinery originated in America, and they are equal to wrought nails where they do not require clinching, which may be considered an exceptional practise in using nails. The rolling and slitting mills of America cut up about 2400 tons of sheet iron per annum into nails and

* Dr. Ure.

brads. At least ten patents were taken out in England between 1820 and 1836 for improvements in the manufacture of nails. I do not know what improvements have taken place since, but the description of the machines and improvements up to 1836 appear to leave little to expect in the shape of improvements, so far as I can judge from the information given by Dr. Ure on this subject. The machinery in the rolling and slitting mills prepare the rods from plate or sheet iron, preparatory to their conversion into cut nails.

In 1858 we imported nails and screws weighing 1983 tons, and valued at £64,302. Probably at least three-fourths of this amount was for nails, which might be advantageously manufactured in Victoria, where the bar and sheet iron can be made from our raw materials.

Founding.—From the evidence given before the Tariff Committee on the 9th March, 1860, an eminent iron founder of Melbourne stated that "manufactured articles made here were about two and a half times the English price, and that the iron founders of Melbourne could not compete with imported articles, except in gold-crushing machinery. That wages were three times as high here as in England, but that suitable mechanics were continually offering their services at half the present rates," showing that the demand, on account of the high rate of wages, was small compared to the supply, and yet there is an evident disinclination on the part of the iron founders of Melbourne to reduce the rate of wages, so that the high price of machinery here is simply the result of an arbitrary trade combination, and any attempt to reduce the wages of mechanical engineers, although for the mutual benefit of the iron founders, their workmen, and the public requiring machinery, would probably lead to a general strike on the part of the men, who now hold the iron founders, and the purchasers of their labor, in subjection, while at the same time not more than one-half the mechanical engineers in the colony are employed, so that, as a body, they are poorer than if they worked for one-third less than at present, when the whole of them might be employed. The same gentleman also stated that "if a new firm were to start with men at less wages than we are paying, we might reduce the wages of our men, in order to compete." Another founder stated "that although there was plenty of ironstone in the country, that there was not sufficient fuel here to manufacture iron." One

would suppose that this gentleman was never ten miles out of Melbourne, or he would not have made such a random statement. There are numerous densely timbered forests in the colony abounding in ironstone; and it is a fact that charcoal may be obtained at Pleasant Creek, and other gold-fields, at less than one-half the price (by weight) of imported coke in Melbourne.

In addition to the abundance of rich iron ores, in combination with either coal or timber, we also have tin ores, which we now export, and can also import any quantity of copper from South Australia, so that iron founders might, in many instances, establish iron-works in many of our inland towns, and if near to a proposed railway, might manufacture the rails and chairs required for the permanent way, the iron girders for the railway bridges, besides innumerable other less weighty articles required, not only for railways, but for quartz-crushing and other machinery; also iron pipes for water-works and gas-works, now the general concomitants of most towns. Although iron founders cannot compete with imported goods or articles in Melbourne at the present rate of wages, yet, as before stated, in certain localities, where the carriage amounts to say more than £5 per ton from Melbourne, it is probable they could successfully compete with most kinds of iron work.

Waste heat.—It must be apparent to most people who have seen the flames bursting out of the tops of the cupolas in which iron is reduced, or pig iron smelted, that great loss of heat must arise therefrom. "In Germany these waste gases have been collected and used as fuel in refining, puddling, and welding furnaces, and even in the generation of steam from steam engine-boilers." * This may be a desideratum where fuel is very expensive.

Victorian Iron.—Since writing the foregoing article on iron, I have been informed by an iron founder in Melbourne that a company is about being formed to establish iron-works about a mile and a half from Sandhurst, near the railway, where there is an abundance of hæmatitic iron ore, with timber, &c., required on the spot. The company contemplates being able to make iron rails for the railway at £8 per ton, or about one-half the cost of the

* Dr. Ure.

imported rails at Sandhurst. Charcoal iron would be far too good for such a purpose, when we consider it makes much better steel than the common or coke iron.

Cost at Sandhurst.—Since two and a half tons of coke is the average consumption in the Staffordshire iron-works for reducing one ton of iron from the iron ore by the cold blast, and one and a half ton by the hot blast furnace; and as charcoal produces fifteen per cent. more heat per ton than coke, and hæmatite contains twice as much iron as the carbonate of iron of England, and therefore only half the bulk, we may safely estimate the charcoal required to reduce hæmatitic iron ore by the hot blast furnace at two tons per ton of iron; this at Sandhurst would cost about £5; the lime required for flux would cost about 10s.; the labor at double the cost in Staffordshire would be 30s.; to which may be added 20s. for the ore, motive power for blast fan, &c., making a total of £8 per ton for charcoal pig iron. This would have to be refined, and rolled into rails, which would increase the cost to about £14. For the same price it could be rolled into rod and bar iron, which, being charcoal iron, would be worth at least £20 per ton in Melbourne, or £25 per ton at Sandhurst.

STEEL.

"With the exception of the Ulverstone charcoal iron, no bars are manufactured in Great Britain capable of conversion into steel equal in quality to that made from the Madras, Swedish, and Russian irons so largely imported for that purpose."* As before stated, charcoal iron is made from hæmatite, smelted and *puddled* with charcoal. We could make such iron here, having the raw materials largely distributed.

"*Bar or Blistered Steel* is merely carbonised iron rods or bars: the process of manufacture is simple, and consists in placing the bars of iron in a *trough* made of fire-clay or fire-tiles; the iron bars are in layers placed on edge a short distance apart, and imbedded in *cement*, (a mixture of ground charcoal and common salt,) as follows: the bottom of the trough is covered with

* Dr. Ure.

cement about two inches deep, and between each layer of iron is a layer of cement about half an inch deep; the *trough* or *troughs* (for there are generally two in each furnace) are surrounded by heated air, *i.e.* the flames of the furnace play round them as with gas retorts; they are sometimes from twenty-six to thirty-six inches square inside, and from eight to fifteen feet long, and being filled to within a few inches of the top, as much as twelve tons of bar iron may be converted into steel at one charge, the process lasting "from six to eight days for steel of moderate hardness, fit for tilting (or hammering) into shear steel; softer steel for saws and springs takes a shorter, and harder steel for cold chisels used in cutting iron, a longer period. The higher the heat of the furnace, the quicker is the process of conversion." *

Cast Steel is merely blistered steel broken up and melted in fire-clay crucibles.

In 1858 we imported 204 tons of steel, valued at £56 per ton.† We can manufacture steel here with advantage, seeing that we have the raw materials of the most approved kind for the manufacture of charcoal rod and bar iron similar to that of Ulverstone, Sweden, India, &c., and also abundance of hardwood charcoal (which is far superior to any kind of softwood charcoal) with the necessary refractory or fire-clays for conversion into fire-lumps, fire-bricks, fire-tiles, &c.; gritstones or millstone grits for the *hearth* of the furnaces, limestone as a flux in smelting iron, and fire-clay for the joints of the brickwork, for *luting* joints of *tap* or trial holes, &c., used for testing the quality of the steel from time to time during its *cementation*.

JEWELLERY.

From the evidence given before the Tariff Committee, on the 2nd March last, I glean the following:—There is a protective duty in England on imported gold jewellery of 17s. 6d. per ounce, and 2s. 6d. per ounce export duty from Victoria, making a total of 20s. per ounce on jewellery made here for exportation to England. There is also a duty of thirty-three per cent. on jewellery imported

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* Dr. Ure.

† In 1859 we imported 223 tons 3 cwt. of steel, valued at £12,711.—C. Mayes, June 29, 1861.

into America, so that both England and America are effectually closed as markets for jewellery made in Australia. Although the wages paid to working jewellers in Victoria are about ninety per cent. higher than in England, if the same import duties were levied here as in England, our jewellers could compete with imported jewellery, which amounted in 1858 to the value of £44,265.* There is no good jewellery imported into Melbourne, although many people may be tempted to purchase it as such, for instances have been known of imported gold jewellery of twelve carats, sent here to be sold as colonial jewellery of eighteen carats fine. To prevent this nefarious practice, a Goldsmiths' Hall is very much required, which would materially lessen the present enormous import of inferior jewellery, because it would have to be scraped or cut before it could be assayed, whereas colonial jewellery might be assayed in an unfinished state (before the gems were set for instance) by ascertaining its specific gravity, or by scraping or cutting, since any slight abrasure might be obliterated or rectified in the finishing. First-class jewellery is almost exclusively made by hand, whereas inferior jewellery is assisted by machinery, dies, &c.

LEATHER.

In 1858, according to our Blue-book, sixty-three tons of leather were imported, and valued at £9200, or about £146 per ton, whereas in the same year fifty-five tons were exported at only £90 per ton; † this was colonial leather, and, judging from the price, little of it was curried, being sole leather chiefly, since but little curried, or upper leather, is made here, in consequence of the great expense attending its manufacture.

The materials employed in the manufacture of leather consist of the hides of cows or oxen, buffaloes, and horses, which are used for the thick sole leather; and the skins of calves, kangaroos, kids, goats, seals, &c., for the more flexible upper leather of boots and shoes. In the conversion of hides and skins into leather the principal material employed is tannin contained in the bark of various trees,

* In 1859 we imported jewellery to the value of £44,067.—C. Mayes, June 29, 1861.

† In 1859 we imported 66¾ tons of leather valued at £10,481, and exported 143 tons 11 cwt., valued at £10,316.— C. Mayes, June 29, 1861.

more particularly our Australian wattle, which is the most valuable bark obtainable for this purpose. In 1858 no less than 166,811 skins, and 124,580 hides, were exported from Victoria, which were valued at £106,463;* this is exclusive of the hides manufactured here into sole leather. In the same year we exported 249 tons of bark, valued at £2800, and these materials have to travel about 30,000 miles before they return to us in the form of leather, boots and shoes, or saddlery and harness. We can produce sufficient hides, skins and wattle-bark to be made into leather for these purposes.

There is evidently a large amount of sole leather prepared from hides in this colony, since in 1858 there were no less than thirty-three fellmongers' establishments, and twenty-five tanneries, three of each, only, being in the county of Bourke; on the other hand, that very few skins are prepared here for upper or light leather, may be inferred from the fact that such leather is curried, and in 1858, according to the Blue-book, there was only one currying establishment in Victoria, and that was in the county of Grant;† this trade is sometimes combined with tanning, although I have reasons to suppose it is but little practised here on account of the great expense as compared with the cost of importing curried leather, and this difference in the cost is entirely owing to the high price of labor attending this process.

In the Melbourne Exhibition, in 1854, could be seen excellent specimens of hide leather tanned with mimosa bark, suitable for harness and boots; since then great improvements have been made, and excellent samples of leather exhibited at the annual exhibitions of the Industrial Society; colonial-made sole and harness leather is now preferred to the imported article.

Parchment is also made here, and samples were to be seen at the Melbourne Exhibition, in 1854. As this is a great wool-producing colony, we might manufacture parchment from sheepskins, not only sufficient for our own consumption but also to export largely; here again the high price of labor stands in the way.

Varieties of Leather.—Other kinds of leather might be made

* In 1859 we exported skins and hides to the value of £172,422, and bark to the value of £1310.—C. Mayes, June 29, 1861.

† In 1859 there were thirty-one tanneries and twenty fellmongeries in Victoria.—C. Mayes, June 29, 1861.

here, such as kid and lambskin for gloves; Morocco or Turkey leather from goatskin; kip, or buffalo, from young oxen; upper leather of ordinary boots and shoes from calves' skin, a softer and more endurable upper leather from kangaroo skin; cordovan for harness, and shagreen for cases, boxes, bags, &c., from horses hides. In the month of May, 1860, an account was given in the *Argus* of the slaughtering of about 800 kangaroos in one day near Geelong; it stated that the kangaroos were afterwards buried or burnt, no allusion being made to the skins, which are even more valuable than calves' skins. I can scarcely imagine (despite the apathy and indifference so often manifested by our should be manufacturers) that the skins of these 800 kangaroos were destroyed.

Harness.—Under the head of saddlery the imports in 1858 amounted to £74,200, and leatherware £6700, together upwards of £80,000.* I cannot imagine that £74,000 worth of saddles could be imported here in one year; the greater part of this amount must be for what is commonly known as harness, which is made from the hides of oxen, horses, calves, &c., the saddles being made from hogskins. Creditable samples of colonial-made harness and saddles were exhibited at the Melbourne Exhibition in 1854, and since then at the annual exhibitions of the Victorian Industrial Society, and may now be seen in the numerous saddlers' and harness-makers' shops in Melbourne; they are fully equal, if not superior, to similar imported articles, as their ready sale testifies; by the Melbourne directory for 1860 I find no less than seventy-eight saddlers and harness-makers in Melbourne and its environs. It might be worth while to adapt machinery to reduce the amount of labor bestowed upon this branch of industry, which, in the absence of cheap labor, might reduce our enormous imports of these articles by increasing at a cheaper rate our own production.

Boots and Shoes were imported into this colony in 1858 to the enormous amount of £652,000,† being equal to about 25s. per annum per head for the whole population, or about £5 for each

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* In 1859 we imported saddlery (which I infer includes harness, since I do not find any entry of harness) to the value of £42,446, and leatherware to the value of £8069.—C. MAYES, June 29, 1861.

† In 1859 we imported boots and shoes to the value of £607,703.—C. MAYES, June 29, 1861.

family; the retail price is about 50 per cent. more than these amounts, and this is exclusive of boots and shoes made in the colony, so that the expenditure for each family cannot be less than £10 per annum.* If only one half, or £326,000 worth of women's and children's boots and shoes, were imported, and the men and large boys of Victoria were to wear boots and shoes of colonial manufacture I do not think that a larger outlay would ensue to the whole population, for, although the price of colonial-made boots and shoes are about double the price of imported ones, yet, as they are well known (by those who have made the experiment) to wear about two and a half times as long, they are found to be actually cheaper than the imported article. The boot and shoemakers of Victoria need no other protection to their trade than the general reception of this fact, which wants only a trial to convince any purchaser of imported boots and shoes of its truthfulness There are many reasons for this, among which are the following, viz., imported boots and shoes are slop-made, the work and material both being inferior; the soles consist of two thin pieces, filled up with fragments of leather, the consequence being that the outside casing forming the lower part of the sole soon wears through, and the boots or shoes (if the *uppers* are worth it) must be re-soled; before this sole is half worn through the sides of the boots open, generally from the upper leather giving way, whereas colonial boots are made of the best material, the soles being colonial sole-leather, and the *uppers* of imported calfskin properly tanned and curried; these never, or very rarely, burst or come unsewn; and the soles, which may be obtained of solid leather at least one-quarter of an inch thick, if they do not last out the *uppers*, the *uppers* will generally bear re-soling, when the boots or shoes are again sound, and even then sometimes superior to those imported.

From the evidence given before the Tariff Committee, on the 10th February, 1860, I learn that it is the general opinion of the trade that if a duty (*ad valorem*) of 20 per cent. were levied upon imported boots and shoes, that the colonial workmen could compete with imported goods, which are, generally speaking, very inferior, and last only from one-third to one-sixth as long as colo-

* I have reckoned the Victorian families to average four; the families of the United Kingdom average five each.—C. MAYES.

nial-made articles; that such a duty would induce the bulk of the workmen who are now engaged in other pursuits to return to their trade, and hundreds of boys and women who would be glad to get into the trade would join them. That although wages here are only 8d. per hour, it is about three times as high as the wages paid to shoemakers in England. All the witnesses examined by the Committee agree that boys would be of great service to the trade, but because the trade is so bad, they will not take apprentices.

Subdivision of Labor.— By a proper subdivision of labor, colonial boots and shoes would be cheapened; this might be brought about by the boot and shoe makers of the colony forming themselves into a company, and contracting to supply individuals and families with boots and shoes at the same rate they have hitherto paid per annum for imported goods, which they might do with advantage, even if their goods lasted only twice as long as those imported. By such a combination they might all find constant employment, and also employ hundreds of women in the light work of ladies and children's boots and shoes, and hundreds of boys who would be apprenticed to them; they would by this means soon outstrip their contract orders, and obtain a large stock of superior ready-made goods, which would soon be bought up as their real value became known.

MALT.

In 1858 we imported 220,777 bushels of malt. The imports for the first six months of 1859 and 1860 show a considerable falling off in the quantity imported.* This is not met by an increase in the growth of barley; on the contrary there is a decrease in the growth of barley in Victoria during the year ending the 31st March, 1860, as compared with the previous year, of 16,528 bushels, which is not owing to any failure in the crops, but to the fact that there were 1200 acres more under crop in 1858 than in 1859.

Mr. S. Egan, a farmer in Victoria, in his evidence given before the Tariff Committee on 21st February, 1860, says:—"There has been but little barley grown here, because the brewers give no

* In 1859 we imported 198,791 bushels, valued at £96,164.—C. Mayes, June 29, 1861.

encouragement for farmers to grow it. Brewers can purchase malt here at such a price that they will not malt themselves, as it requires a large outlay of capital;" and in corroboration of there being but little demand for barley here, Mr Egan states "that he had sold 1200 bushels of barley last week at 5s. per bushel," being less than the estimated value of 5381 bushels (the whole of the barley) imported in the first six months of the year 1860, which was valued at 6s. per bushel.

With the view of encouraging the growth of barley and the manufacture of malt in Victoria, this gentleman recommends an *ad valorem* duty of "3s. per bushel on imported malt, and 2s. 6d. per bushel on imported barley;" this would have increased the value of barley as then imported to 8s. 6d. per bushel, whereas this same gentleman was compelled to sell his barley at 5s. per bushel. It is very clear from the foregoing facts that there has been a great falling off, not only in the importation of barley and malt, but also in the growth of barley in Victoria, and consequently in the consumption of malt, although the manufacture of colonial beer has rapidly increased. (*See* "Beer.")

From the great care taken in shipping malt for this colony, it is landed here perfectly uninjured by its transit from Britain. "It is packed in zinc cases, hermetically sealed, and surrounded with three-inch deals," as stated by one of the first brewers in Melbourne, in a letter addressed to the Editor of the *Argus*, in June, 1860. He also stated in this letter that "four of the principal breweries in Melbourne produce 600 hogsheads of beer weekly, and that the proprietors in the aggregate give a premium of upwards of £100 annually for the best sample of barley grown in the colony, and that he had, at an expense of upwards of £2000, erected a malthouse on his property, in the hope at no distant period of being able to dispense with importations of the principal *ingredients* used in the manufacture of colonial ale, and thus give an impetus to another important but somewhat languishing branch of colonial industry."

About a week after the above letter appeared in the *Argus*, the *Creswick and Clunes Advertiser* gave a description of Quinn's malthouse and brewery in that neighborhood. "The malthouse is a two-story building, the *growing floor* being 8 feet under ground, and made of cement; the tank for steeping the barley is able to contain 200 bushels. The withering floor (which is the upper

floor) is also made of cement; on this floor the barley remains until in a fit state to go to the kiln." There is also an ingenious machine for sifting the malt after it comes from the kiln, and two mills for grinding or crushing it. A moderate and uniform temperature is best adapted for malting, and for this reason the walls of the malthouse should be thick, and if partially underground, as above, a more uniform temperature is most likely to be obtained, at least on the lower floor. A suitable temperature is about 60°, and this would be difficult to maintain during the summer.

Malted barley is generally used in the manufacture of "gin," and "whiskey" (which see). Malt, when used for distillation, should always be of the palest kind, and steam dried; although raw grain is likewise used for this purpose, it is generally mixed with malted barley. "Cape barley would be a good distilling barley, being light," and in this respect resembling "*bere*," which is used in the manufacture of gin. "Barley, if partially malted, will produce from 16 to 20 gallons of spirits per quarter; taking the average crop of barley here at 32 bushels per acre, an acre would produce from 64 to 80 gallons of spirits;" and for this purpose barley would be a profitable crop were it not for the duty of 10s. per gallon levied on all spirits distilled from grain in Victoria. Until this enormous duty is diminished, there is but little likelihood of any considerable quantity of spirits being distilled here.

Brewers also find that they can produce good wholesome palatable beer throughout the colony from other saccharine matter than *malt*; they therefore use *sugar* as the cheapest substitute for malt. The most conscientious brewer will not brew wholly from malt when it is at its highest price; he only considers himself bound to use saccharine matter of a certain value per barrel of beer; and, therefore, as malt rises in price, the consumption of sugar by the brewer increases. In 1858 we imported sugar to the value of £636,912;* the imports during the first six months of 1859 and 1860 were £398,245 and £347,729 respectively, showing a considerable increase since 1858, whereas the importation of malt during the first period has materially decreased, as I have before shown.

* In 1859 we imported sugar to the value of £803,854.—C. MAYES, June 29, 1861.

OILS.*

Oils, unctuous, fat, or fixed, are generally obtained by expression. Animal fats are granular, and consist of small sacs or bags of fat, which vary in size and shape in different animals. Neats-foot oil is made in the colony, and is used chiefly by harness-makers.

Sperm oil.—In 1858 we imported sperm oil to the value of £7871. Many years before the foundation of the colony, the Messrs. Henty established a whale fishery at Portland Bay, and this locality is still noted for the frequent capture of whales, one of about 60 feet in length having been recently captured and valued at £400. The whale lately killed in Hobson's Bay and tugged up to Sandridge pier, was about the same size. Whales are also occasionally captured in Twofold Bay; and there appears to be a wide field open on our coasts for enterprising capitalists to fit out whaling parties. The blubber of the whale from which the oil is obtained is of great thickness, and has been known to yield upwards of 100 tons of oil from one whale; this is not the only product, since the jaws furnish large quantities of whalebone, and the head, spermaceti, which fills the larger portion of the cavities of the head and certain parts of the body.

Porcine oil, made from *lard,* was very much used for lamps in Melbourne until superseded by *Kerosene* oil, which is distilled from anthracite coal in the United States of America, and is now generally used with the Kerosene lamps throughout the colony.†

Vegetable oils.—Those imported consist of Colza, Linseed, Olive, and Rape oils, of which in the aggregate 83,467 gallons were imported in 1858, valued at £23,313.

Dr. Ure, in his dictionary, gives a list of 41 plants yielding the ordinary unctuous oils of commerce, among which are the Hemp plant, Olive, Almond, Cucumber, Beech, Sunflower, Rapeseed,

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* In 1859 the quantity and value of imported oils was as follows:—sperm, 21,899 gallons, £6888; colza, 27,961 gallons, £8506; linseed, 81,871 gallons, £17,944; olive, 10,815 gallons, £2868; and rape, 16,964 gallons, £4561.—C. Mayes, June 29, 1861.

† This information I received from an importer of Kerosene oil, in August, 1860. It may also be obtained from rock oil. *See* note on "Tar," under article "Gas."—C. Mayes, June 29, 1861.

Castor, Tobacco, Plum, Grape, Cocoanut, Palm, Laurel, Groundnut, Colza, Cherrystone, Horse-chesnut, &c.

Colza oil.—Colza oil is an excellent lamp oil, and is produced from a nut grown in France, which yields two-fifths of its weight in oil; it is much used in France, and is also used as a lamp oil in Victoria. The quantity imported in 1858 was about the same as Rapeseed oil, viz., 12,860 gallons.

Rape oil.—"Rapeseed oil has a yellow color and a peculiar smell; at 25° Fahr. it becomes a yellow mass, consisting of 46 parts of stearine and 54 of oleine, in which the smell resides." Rapeseed produces about 27 per cent. of oil.*

"*Hempseed oil* has a disagreeable smell and a mawkish taste; it is used extensively for making both soft soap and varnishes."

"*Linseed oil* is obtained in greatest purity by cold pressure; but by a steam heat of about 200° Fahr. a very good oil may be obtained in larger quantity. When kept long cool in a cask partly open it deposits masses of white stearine along with a brownish powder: this stearine is very difficult of saponification. Linseed yields from 20 to 25 per cent. of its weight in oil."*

Linseed.—"The chief difference in the quality of the oil depends upon the quality of the seed used. Heavy seed will yield most oil, and seed *ripened under a hot sun* and where the *flax* is not gathered too green, is the best. The weight of linseed varies from 48 to 52 lbs. per bushel, 49 being about a fair average; a quarter yields about 14½ gallons of oil, weighing 7½ lbs. per gallon."* It is crushed by machinery with stampers resembling the stampers of quartz-crushing machines, which drive wedges between two bags of linseed, by which means they are effectually pressed, the oil freely exuding during the stamping, and leaving an oil-cake, upon which cattle are fed. "In London a 20 horse-power engine, with 13 light stampers, one hydraulic press of 800 tons pressure, 1 pair of rollers, 2 pair of edge stones, 8 table kettles of a small size heated by fire, will crush two quarters per working hour, with two pressings."*

Linseed Oil Plant.—The Linseed Oil Plant grows in all climates from Petersburgh to the East Indies If grown at all in Victoria it is not to such an extent as to find a place in the Agricultural Statistics of 1858. The best and heaviest seed is generally

* Dr. Ure.

grown and ripened in a warm climate, so that it might be largely grown here, not only for its oil, but also for its refuse or oil-cake.

"*Olive oil* is sometimes of a greenish and at others of a pale yellow color. There are three kinds of olive oil in the market: the best is obtained by pressure when cold; the common sort is procured by stronger pressure, aided with the heat of boiling water; and an inferior kind by boiling the olive residuum with water, whereby a good deal of mucilaginous oil rises and floats on the surface. The latter serves chiefly for making soaps."* The manufacture of olive oil is likely to become an important branch of colonial manufacture, not only for our own consumption, but also for exportation. In 1858 we imported 8715 gallons of olive oil. I am not aware that the olive has been grown to any extent in Victoria, but when we consider the similarity of climate of the countries bordering on the Mediterranean, and Victoria, we may safely predict that the olive will be largely grown here within a few years. Taking the temperature of Naples as an average of the olive-growing countries, and comparing it with Melbourne, I find that the difference of the average heat of either of the four seasons, does not in any instance exceed 5°; the difference in the average annual heat being only 2½ degrees.

Rape, Sunflower, Almonds, Vines, Fruit Trees, &c.—*Rape* has been grown to advantage in the Experimental Farm; the sunflower also grows freely here, as well as both sweet and bitter almonds, plum trees, vines, cherry trees, cucumbers, linseed, &c.; the whole of which, as before stated, produce the unctuous oils of commerce.

Castor Oil, Tobacco, Olive, Colza.—Other oil producing plants, the growth of which hitherto in Victoria must be regarded as experimental, may yet flourish here, such as the castor oil plant, the tobacco plant, olive tree, colza oil plant, &c.

"*Oil of Vine Stones* is extracted from the seeds of the grape, which yield about 10 or 11 per cent of oil; it is used as an article of diet,"* and will become worthy of attention as our vineyards increase.

"*Oil of Almonds* is manufactured by agitating the kernels in bags so as to separate the brown skins, grinding in a mill, then enclosing them in bags, and squeezing them strongly between cast-iron plates in an hydraulic press, without heat at first, and

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* Dr. Ure.

then between heated plates. The first oil is the purest and least apt to become rancid. Next to olive oil this oil is most easily saponified. Bitter almonds being the cheapest in England, are used in preference for obtaining this oil, and they afford an oil equally bland, wholesome, and inodorous."* Almonds are produced in Victoria in great perfection, although not in sufficient quantities to be used for this purpose at present, but could be whenever the manufacture of scented soaps and other perfumery render it necessary.

Paraffine.—From Dr. Ure's article on paraffine I learn "that it is distilled from beech-tar; in distilling beech-tar pyrélaine passes over, containing crystalline scales of paraffine, which is a white substance, devoid of taste and smell, and feels soft between the fingers; it *burns with a clear white flame*, without smoke or residuum, and has the same composition as olefiant gas. It dissolves readily in warm fat oils, and is a singular solid bicarburet of hydrogen; it has not hitherto (1843) been applied to any use but would form admirable candles." It would appear from this that some one has taken up Dr. Ure's suggestion by dissolving crystals of paraffine in warm oil, and given the compound the name of Paraffine oil, to be used in lamps; an oil is sold in Melbourne as *Paraffine*, which resembles *Kerosene* in many respects, but is darker, smokes when consumed in the Kerosene lamp, and while smoking emits a disagreeable odour: this last oil may be only a substitute for the real Paraffine, or the fact of its smoking in a certain kind of lamp may merely shew that the lamp is not adapted for its perfect combustion; there is at present such a great variety of lamps of different construction more or less in use, that in all probability a more suitable lamp will be found for it.

Oils volatile or essential occur in different parts of odoriferous plants, and in some instances in all parts of the plant, as in thyme, parsley, fennel, sweet marjorem, lavender, southernwood, &c. Some plants, as the orange, furnish different kinds of oil from different parts of the plant; thus the leaves, the flowers, and the skin of the fruit yield each its peculiar oil. "The quantity of oil varies not only with the species, but also in the same plant, with the soil, and especially the climate, it being generated most profusely in hot climates. In flowers it is formed continually

* Dr. Ure.

upon their surface, and flies off at the moment of its formation,"* so that immense quantities of rose leaves (according to the *Athenæum* about 600 lbs.) are required to produce one ounce of the oil or otto of roses; other blossoms, such as violets, orange, acacia, jessamine, hyacinths, and other tuberoses, white lilies, &c., require a much smaller quantity, since 500 lbs of orange blossoms yield about two pounds of pure neroli oil: the chief places of their growth have hitherto been confined to the south of France and Piedmont. The French, favored by their climate, furnish half the world with this branch of their industry. The south of France is bounded by the Mediterranean, which I have before shown bears a striking resemblance in climate to Victoria, so that the whole of the above-mentioned plants and flowers might be grown here with equal advantage to Victoria as they have hitherto been to France.

Oil from flowers.—As I have before stated, the perfume of flowers is formed continually upon their surface, and flies off at the moment of its formation, and this is why such large quantities of flowers are required to obtain such a very small quantity of their oil or essence, which is retained by packing alternate layers of flowers and thin cotton fleece, or woollen cloth wadding, previously soaked in a pure and inodorous fat oil to catch the perfumes as they fly. It appears to me that a much larger quantity of oil might be obtained by covering the flowers while blooming or blowing with a similar preparation of cotton or woollen, by which means the perfume instead of "wasting its freshness on the desert air" (or at most for the benefit of a few workmen or visitors) might be retained by the unctuous covering, all volatile or essential oil having a peculiar affinity for unctuous fat or fixed oils, and when so retained could be distilled in the same manner as it now is from the unctuous cotton or woollen layers, which are submitted to distillation along with water when they give up their precious perfumes in the form of a volatile oil. "In order to extract the oils of certain flowers, as, for instance, of white lilies, infusion in a fat oil is sufficient."* On account of the great value of pure volatile oils from flowers they are generally mixed with alcohol, or "adulterated with fat oils, resins, or balsam of capivi,"* but the adulteration can generally be detected by simple tests.

"*Oil of lavender* is extracted from the flower spike of the

* Dr. Ure.

lavandula spica." The oil of spike of commerce is distilled from a wild variety of the same plant.

Oil of orange flowers or neroli is obtained as before stated. "Orange-flower water is obtained either by dissolving the oil in water, or by distilling with water the leaves, either fresh or salted, the first being the stronger, but the last being the more fragrant preparation."* Nice and Cannes together produce about 300,000 lbs. of orange blossoms annually.† I look forward to the time when the banks of the Murray below the Campaspe will teem with orange plantations, not alone on account of the perfume to be obtained from their blossoms but also on account of the valuable oil expressed from their leaves, and the rind of their fruit, or orange-peel, which contains a large quantity of oil, as any one can attest by simply squeezing a piece of orange-peel between their finger and thumb into the flame of a candle, when the oil from the peel will readily take fire. This oil is easily obtained by expression, and is used largely in scenting soaps and other perfumery. From the large quantity of essential oil obtained from orange-peel it might and probably would be found profitable to collect, by purchase or otherwise, the immense quantity now wasted in the colony; it could be expressed in the same way as linseed (which see).

Oil of bergamot, lemons, citron, &c., is obtained in the same way from the rind of the fruit.

"*Oil of bitter almonds* is prepared by exposing the bitter almond cake, from which the bland or unctuous oil has been expressed, in a sieve to the vapor of water or steam rising within the still, which carries off the volatile oil and condenses along with it in the worm of the still."* Perfumers employ a large quantity of this oil in scenting their soaps. The other essential oils likely to be manufactured here are the oil of juniper, which is obtained by distilling bruised juniper berries along with water; the oil of parsley, peppermint, rosemary, sassafras, thyme, acacia and jessamine blossoms, violets, hyacinths, and other tuberoses, &c.

PAPER.

In the year 1858 we imported paper, in the form of stationery and paper-hangings, to the value of about £200,000.‡ During the

* Dr. Ure. † *Athenæum.*

‡ In 1859 we imported stationery to the value of £174,796, and paper-hangings to the value of £29,341.—C. Mayes, June 29, 1861.

same year we exported 516 tons of rags, which was probably not one half the quantity of rags that might annually be obtained here, because, in the first place, it is not generally known that rags are purchased in the colony, and, in the second place, the price given is so trifling as compared with their market value at home that few would care to save them for sale. As long as rags are purchased for exportation the price given will be very small; were paper-mills to be established here a larger price would be offered, and we should not then be in the habit of seeing cast off wearing apparel among our numerous rubbish heaps, or in the back yards and right-of-ways of our city and towns.

Up to the commencement of the present century paper was made entirely by hand, when the labor cost about 16s. per cwt.; the cost is now about 1s. per cwt. "This great change has been chiefly effected by Donkin, who has made for himself a place along with Watt, Wedgwood, and Arkwright, in the temple of mechanical fame."* Independent of the great superiority of machine over hand-made paper, manufacturers are not troubled with combination of workmen forming strikes, which was one of the serious drawbacks to the manufacturer of hand-made paper, another drawback being the large amount of waste, generally about 20 per cent., whereas by machinery it is a mere nothing. "Even so far back as 1843 there were 280 machines working in Great Britain, producing together 1600 miles of paper, from four to five feet broad, every day."* The great improvement in the patterns of china and earthenware is due chiefly to the manufacture of a superior description of tissue paper, "the hand-made paper being too coarse to trace the fair engravings required."* There is also an advantage when used for this purpose in the paper being of great length, and even in 1834 tissue paper was used in the potteries 1200 yards long; this length of paper, or in fact any great length, had never been made by hand labor. "In 1843 each machine was capable of making under the impulsion of any prime mover, unwatched by human eye, and unguided by human hands, from 20 to 50 feet in length by 5 feet broad of most equable paper in one minute."* Since then several patents have been taken out for improvements in paper-making machinery.

"The Chinese not only use rags in the manufacture of paper,

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* Dr. Ure.

but also the fibres of the young bamboo, of the Chinese mulberry tree, the envelope of the silkworm cocoon, cotton down, and especially the cotton tree; they also make paper from their myrtle tree." *

In 1857 (Nov. 18th) a Mr. Alexander Tolmer obtained a patent in this colony for the manufacture of paper and pasteboard from the stems and leaves of the plant known as the *Lepidos sperma gladiata*, and also from the root, stem, and leaves of the *Hybiscus* or marsh-mallow. This last plant grows luxuriously and spreads rapidly in deserted sheep stations, homesteads, and other places where it is not destroyed as a weed.

Paper Plant.—The Mineral Point *Tribune* has a description of a plant with the above name, discovered in Wisconsin by Miss A. L. Beaumont, who describes it as follows: "I discovered two years ago a plant that yields both cotton and flax from the same root, and I believe I am the first person that ever cultivated, spun, and knit from it. I am persuaded that any article that will make as good cloth as can be made from this plant will make good paper, hence I call it the 'paper plant.' It can be planted in the spring and cut in the winter. It bleaches itself white as it stands, and will yield at least three or four tons to the acre. From a single root that I transplanted last spring there grew 20 large stalks with 305 pods containing the cotton, with at least 60 seeds in each. From this root I obtained 7 ounces of pure cotton and over half-a-pound of flax. It is a very heavy plant, and grows from six to seven feet high. The editor of the *Tribune* who has seen samples of the cotton from this plant thinks that as an article for the manufacture of paper it must be far better and cheaper than any other known."—*Australian Builder*, Oct. 2nd, 1856.

As the proper cotton tree grows best within the tropics, and, therefore, not likely to be successfully cultivated in Victoria, it is interesting to know that the paper plant is indigenous to Wisconsin, which lies between 43° and 49° N. latitude, and assimilates more to the climate of Victoria than to that of the tropics. We may, therefore, reasonably expect to find but little difficulty in acclimatizing the paper plant in Victoria, to which it would be a most valuable acquisition.

* Dr. Ure.

Paper from Maize.—The *Illustrated London News* by August mail, 1860, contained an article on the "maize plant" which stated, among other important facts, that "The productiveness of this plant being so great, it is not to be wondered at that efforts have been made to cultivate it in Great Britain, and many years ago the late William Cobbett, of political celebrity, wrote a book on its virtues, recommending it to the British farmer. The *leaves and straw make good paper*, and Mr. Cobbett's book was printed on paper made of this material." It has been tried in England, but as was to have been expected, the average temperature of the seasons was not high enough to ensure the ripening of the grain. It is extensively cultivated in both N. and S. America from the tropics to 40° N. and S. latitude. It also produces good crops in Victoria, 7012 bushels being the produce of 750 acres during the year ending 31st March, 1860; this must either be a false return, or shows inferior cultivation, the average produce per acre being less than 10 bushels. From the Report on the Resources of the Colony I take the following:—"We are informed by A. McMillan, Esq., the discoverer of Gipps Land, that not less than 80 bushels of maize per acre for several successive years have been obtained on that gentleman's estate on the Avon River, whilst the yield of wheat amounted to 35 bushels; oats, 50 bushels; barley, 45 bushels; and potatoes 6 tons to the acre."

In addition to the paper plant, which may be grown here, and the leaves and stalks of maize which, with proper management, produces large crops, we have the flax plant, (a very fair crop of which was obtained in 1858, on the Experimental Farm, near Melbourne, and the fact that it will thrive well in this climate has, therefore, been fully established); * and several trees and plants indigenous to the colony, the bark of which might be converted into the coarser, if not the finer, kinds of paper. The cotton tree might also be grown on the north side of the River Murray, and the cotton transmitted to Melbourne by the Government railway now being made between Melbourne and the River Murray. The cotton tree could also be grown in the northern parts of South Australia and New South Wales; it has been already successfully cultivated in Queensland.

We have, therefore, abundant sources of material suitable for

* Report on the Experimental Farm.

the manufacture of all kinds of paper, and, as I have before shown, since 1843 it has been made in England with machinery so perfect as to require a very small amount of manual labor to produce miles or tons of paper. Even at the present rate of wages, with imported machinery propelled either by the Yan Yean water or the Yarra Falls, paper might yet be made in Melbourne as cheap as that imported.

Tracing Paper of the "best kind is made from the refuse of flax mills, and prepared by the engine without fermentation: it thus forms semi-transparent paste, and affords transparent paper." *

Paper Pipes.—An extract from an English paper appeared in the *Argus* of the 20th August, 1860, giving particulars of the "paper pipes" invented by a Mr. John Kennedy, which are likely to (a considerable extent at least) supersede the use of iron, lead, and clay pipes for "water, gas, or sewerage; they have been proved to stand a pressure of from 220 to 250 lbs. per square inch," which is more than sufficient for any practical purpose they can be applied to. "Then look at the price: a 3-inch pipe can be had at the rate of 1s. per yard, and other sizes in proportion;" a yard of 3-inch iron pipe ⅜ of an inch thick would cost at least 3s. in England! "When they were referred to by Mr. Gladstone in his celebrated speech of the 10th February last, the idea of paper pipes was scouted; since then they have been largely patronised by the Government and many public bodies. In fact, the patentees for England cannot even meet the orders they receive." I have been given to understand on good authority that the patent has been extended to this colony, the patentees having an agent here, so that if they are not exchanged for our deleterious lead pipes now supplying water to the inhabitants of Melbourne and its suburbs, we may at least hope to see them used in our contemplated water and gas works throughout the colony.† It is not at

* Dr. Ure.

† Patent bituminised paper pipes are now made in Melbourne, samples of which have been tested by a Government Committee, from whose report dated April 29th, 1861, I learn that the pipes were "tried by hydraulic pressure, and 499 lbs. per square inch caused no leakage or breakage in a pipe 7½ inches external and 6¼ inches internal diameter." The pipes are estimated to withstand a bursting pressure of 300 lb per square inch; and the Committee feel that the excess named above that amount was ample as

all improbable that they will yet be made in the bush partly from the bark of our numerous forest trees.

PERFUMERY.

In 1858 we imported perfumery to the amount of £4267, exclusive of perfumed or scented spirits, which amounted to £13,021.* Under the head of "Oil" I have given particulars of the unctuous and essential oils, many of which are used in manufacturing pomatum or pomade, scented or perfumed oils and spirits, (and more especially "Eau de Cologne"), pastes, pastilles, &c.

Had we to import the principal ingredients required to manufacture perfumery, or perfumed spirits, it might not be worth particularising in this Essay; but when we consider that the whole of the ingredients are either produced or may be produced in this or the adjoining colony, and that we have no other use for the immense quantity of china or glassware in which they are imported, and which in many instances are as valuable as their contents, it seems probable that at no distant period we may not only manufacture for our own use, but also for exportation. As before stated, when treating of "Oils," "the South of France supplies at least half the world with perfumes." Some idea may be entertained of the magnitude of this branch of industry from an extract from the *Athenæum*, by which I learn that "Cannes and Nice produce 13,000 lbs. of violet blossoms annually. One great perfumery distillery at Cannes, uses yearly about 140,000 lbs. of orange blossoms; 20,000 lbs. of acacia blossoms; 140,000 lbs. of rose leaves; 32,000 lbs. of jessamine blossoms; 20,000 lbs. of violets, and 8000 lbs. of tuberoses, together with a great many other sweet herbs."

Pomades or Pomatums, are made by mixing in a peculiar manner hog's lard, beef suet, and the leaves of the flowers whose perfume is required; these materials undergo certain preparations, simple and easily understood, but which I need not refer to more

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evidence of the power of internal resistance. For further particulars, see Government report, to be obtained at the Depôt, 127 Flinders lane east, Melbourne.—C. Mayes, July 1, 1861.

* In 1859, we imported perfumery to the value of £6812, and perfumed spirits to the value of £11,553.—C. Mayes, July 1, 1861.

particularly. As a substitute for flowers, which are too valuable except for the best pomades, "the essences commonly used in the manufacture of pomades, are those of bergamot, sweet lemon, rosemary, thyme, lemon thyme, lavender, marjoram, &c."*

Scented Oils are made by infusing flowers in pure fresh oil, such as rose leaves, orange flowers, &c.; the more delicate flowers, such as jessamine, jonquil, and violet, are spread upon stretched calico, saturated with salad or other suitable inodorous oil; fresh flowers are renewed until the oil is saturated with their odour, the calico is then pressed to obtain the scented oil, which operation requires seven or eight days.*

Essence of roses, orange flowers, violets, &c., are obtained by distillation, which is repeated for the best kinds.

Scented or perfumed spirits, of which so large a quantity are annually imported into this colony, are obtained by *digesting* 25 lbs. of the scented oil of roses, orange flowers, jessamine, or violets, &c., and 25 quarts of spirits of wine, for three days, when the perfumed spirits are drawn off.*

Eau de Cologne.—"The only essences which should be employed, and which have given such celebrity to this water, are bergamot, lemon, rosemary, Portugal, neroli, or the essence of orange flowers."*

Pastes are made from the kernels of apricots, almonds, &c.

Pastilles for burning are made with gum, nitre, cloves, charcoal powder, vanilla, &c.

Vanilla is the oblong narrow pod of the *epidendron vanilla*, Linn., which grows in Mexico, Columbia, Peru, &c. It has a delicious aroma, and is much sought after by makers of chocolate, ices, creams, by confectioners, perfumers, and distillers;* and is, therefore, a fruit well worth cultivating in Australia.

PISÉ.

I would call the attention of the public to the consideration and trial of pisé, as a substitute for brick and stonework, in the numerous, comfortable and cheap class of buildings required in this colony, such as *cottages, houses, homesteads, and country inns*, with their necessary *outbuildings and fences*; also *village churches, chapels, and schools*; and, in fact, to all purposes to which second-

* Dr. Ure.

rate brick or stonework can be applied. Pisé is a French word, and refers more to the method of moulding earths by compression into walls, &c., *in situ*, than to the material used.* At least twenty patents have been obtained in England during the last twenty years for artificial stones, or substitutes for brick and stonework; and although the majority of these inventions were deemed worthy of notice for a time, they were ultimately lost to the public, because they were found to be as costly or even more so than brick or stonework.

The common kind of pisé has been in use more or less since it was used by the Romans, in the time of Pliny, who speaks of buildings of compressed earth so durable as to be worthy of his especial notice. This kind of pisé has always been in use in most civilized countries, and has commended itself for its cheapness and durability. In Mexico, and some other parts of America, pisé houses are in general use. The city of the Mormons, on the Great Salt Lake, is built of pisé. In this colony little has hitherto been done, although I have seen at Yan Yean common pisé houses about twelve years old, and the conspicuous pisé tower known as Bear's Castle.

Concrete Pisé.—Concrete is a mixture of sand, gravel, and common lime, in proper proportions to form an artificial stone. In Great Britain, it is extensively used in foundations, particularly for bridges and other engineering works. It seems to have been little used in this colony; and I have seen valuable buildings cracked from top to bottom by unequal settlement, the foundations of which are saturated with water; this might have been prevented by the use of concrete. About the year 1837, Ranger's patent concrete made its appearance, in the walls of two important buildings in London, under Sir Charles Barry, the eminent architect. Mr. Ranger also built with his patent concrete several docks, wharves, the great sea wall of Brighton, (2000 yards long, and in parts 40 to 70 feet high), a church, a school (on the model of the Propylœa, at Athens), and several houses.† In 1851 I saw some concrete pisé houses at Norwood, near Adelaide, which, I believe, are still standing.

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* For the method of constructing pisé walls, &c., see Weale's Rudimentary Treatise on Cottage Buildings, Cresy's Cyclopædia of Civil Engineering, &c.—C. Mayes, July 1, 1861.

† *See* Civil Engineers and Architects' Journal.

Beton Pisé.—Beton is the term given in France to a kind of concrete, made with hydraulic or water lime, and more generally used on the Continent than concrete is in England, for we find it applied not only to foundations and walls of houses, but also to a bridge, which, in 1840, was wholly built of *beton*, over the canal at Garonne: it was about forty feet span, and only five feet rise, and has stood some severe frosts without injury.

Although the application of concrete has been generally successful, it has failed in hydraulic works, such as the sea wall of Brighton, and the Woolwich and Chatham Docks; the reason of this is simply that proper hydraulic lime was not used in the face of the walls to protect them from the destructive effects of waves, tides, and frosts. It will be found in all such cases, where good strong hydraulic lime was used, the result has been satisfactory. Any one who has seen the *beton* walls of the Roman Tower of St. Alban's Abbey, and the massive concrete walls of Colchester Castle, will need no other conviction of the durability of this material, when applied to external walls. The greatest enemy to the preservation of *pisé*, *beton*, or concrete, is the action of the frost; and as they have been found to answer even in cold climates, I have good reason to suppose they will answer much better here, where it seldom freezes. Pisé has been brought to great perfection in most warm climates, and is in more general use on the Continent than in England.

The Victorian Industrial Society has from year to year offered premiums for the best method of manufacturing pisé, but I am not aware that their exhibitions have been attended with any marked success in this or any other branch of colonial industry, and the society has since died from the want of patronage.

In spite of the inferiority of either bark or slab huts, and the inefficiency of wooden houses to meliorate the sudden changes of temperature to which this colony is at all seasons so liable; and although neither bark, slab, or boarded houses, will keep out the intense heat of our Australian summers, so effectually as either stone, brick, or pisé, we still find such miserable substitutes for comfortable dwellings being erected throughout the bush, and slab huts with gaping chinks between every slab, occupying the place of equally cheap and really comfortable pisé walls, made of either loam, brick-earth, cobs or sods, concrete, *beton*, &c.

Under the head of cement and lime, I have shown how preva-

lent and universal is either limestone, cement-stone, or calcined earth; that the calcined earth would form a substitute for the real puozzalano of Italy, and that having limestone and cement-stone, combined with abundance of timber as fuel, we can readily manufacture lime or cement, and build concrete or *beton* walls without skilled labor.

POTASH.

Potash, or *Potassa*, so named because originally obtained from the lixivium of wood ashes evaporated in iron pots. "If lime is added to the solution of ashes, a corresponding portion of caustic potash will be introduced into the product with more or less lime, according to the care taken in decanting off the clear ley for evaporation."

"In America, where timber is in many places an incumbrance upon the soil, it is felled, piled up into heaps, and burnt, solely with a view to the manufacture of potash,"* which is also largely produced in Canada; in a similar manner "the farmer finds what is equivalent to a valuable crop; some extra trouble is, of course, necessary in the manufacture, but in many cases the product is sufficient to pay both for the land and the clearing."† Throughout Australia, although thousands of tons of timber are burnt annually, the ashes are never lixiviated for the purpose of obtaining potash; not that we have no use for it, since it forms an essential constituent in the manufacture of soft soap, and we have had soap manufactories in Victoria for many years. It is also used in the manufacture of glass (see "Glass"), for which it will be required here, when the natural facilities we possess for the manufacture of glass are better known.

Water containing potash is softened by its presence, and this is the reason that the waters of the Yan Yean Reservoir are rendered so deleterious by contact with lead. The bush fires periodically occurring on its watershed deposit the wood ashes of the timber consumed, which is lixiviated by subsequent rain-falls, and finds its way into the reservoir, or, before the reservoir was formed, on to its site, an immense swamp, which from time immemorial has been periodically impregnated with the lixivium of wood ashes or potash. When the immense embankment was about being con-

* Dr. Ure. † Canadian Correspondent.

structed across the entrance to the amphitheatre of hills forming the Yan Yean Reservoir, the timber upon its site was felled and burnt, not only into charcoal, which would have purified the water, but also into ashes, which has increased the presence of potash.

"All kinds of plants do not yield the same quantity of potash, although all plants yield more than trees. The more succulent the plant the more potash does it afford, since it is only in the juices that the vegetable salts reside, which are converted by burning into alkaline matter." "Canadian potash, as imported in casks, contains about 60 per cent., and the best pearlash 50 per cent. of absolute potassa." "The proportions of absolute potassa contained in 1000 parts of certain plants, are as follows, viz. :—Flax stems, 5; vine shoots, $5\frac{1}{2}$; barley straw, $5\frac{1}{3}$; fern, $6\frac{1}{4}$; large rush, $7\frac{1}{4}$; stalk of maize, $17\frac{1}{2}$; bean and sunflower stalks, each 20; thistles in full growth, $35\frac{1}{3}$; dry straw of wheat before earing, 47; wine lees, dried and pressed, 160." Stalks of tobacco, potatoes, broom, heath, furze, sorrel, vine leaves, beet leaves, and many other plants abound in potash salts."

"*Pearlash* is prepared by calcining potash upon a reverberatory hearth till the whole carbonaceous matter and the greater part of the sulphur is dissipated, then lixiviating the mass, evaporating the clear ley to dryness in flat iron pans, and stirring it towards the end into white lumpy granulations"*

By mixing and otherwise manipulating lime with potash, caustic potash, or common caustic is produced. Carbonate, sulphate, nitrate, tartrate, &c., of potash, are obtained by certain chemical manipulations.

POTTERY.

Pottery is made from infusible earths which are refractory in the kiln, and continue opaque, such as earthenware, stoneware, flint-ware, delftware, ironstone, china, &c.

Improvements by J. Wedgwood.—"The greatest improvements in the manufacture of pottery and porcelain or china are due to Josiah Wedgwood. So sound were his principles, so judicious his plans of procedure, and so ably have they been prosecuted by his successors in Staffordshire, that a population of 60,000 operatives in

* Dr. Ure.

1843 derived a comfortable subsistence, within a district (formerly bleak and barren) of about 48 square miles in area, and which in 1843 contained 150 kilns, and was then, as it is now, significantly called the "Potteries."* Were an enterprising potter, with sufficient capital at his command, to endeavor to bring about such a change in Victoria as the enterprising indefatigable Wedgwood effected in England, his task would probably be far less arduous, since he would merely have to apply such materials as were at hand, and for every step and nearly every improvement he might find a precedent in the labors of Wedgwood, now so fully developed and understood. The truth of this statement will be made more apparent by the information I shall endeavor to convey in the course of this article.

Clays.—The pottery clays of England are in such demand that from 50,000 to 70,000 tons of blue clay are annually sent out of Dorsetshire, most of which finds its way to the Potteries in Staffordshire. This branch of industry alone finds employment for upwards of 7000 operatives merely in preparing the clay, which yields to St. Austell alone upwards of £240,000 every year.† Feldspar is also sent from Cornwall to the Potteries, and immense quantities of flints from the chalk formations of Yorkshire, &c., to the same place.

Victorian materials.—We possess all the materials required for the manufacture of earthenware and porcelain.

In the Report emanating from the Committee of the Royal Society of Victoria, I find it stated that "clays of a most excellent kind, suitable for bricks, and for the finest pottery, have been discovered at Phillipstown, Brunswick, and Hawthorn, and bricks are now made which are believed to be equal, in durability, to those of which the old Roman walls were constructed."‡

Mr. Selwyn, also, in his geological reports, refers to clays suitable for pottery of all kinds, occurring in many parts of the colony, exclusive of the fire-clays of our coal-fields.

Flints.—There are no flints in Australia; at least, none have yet been discovered, since we possess no chalk with which they are always associated. As a substitute for flints we have an abundance of pure milk-white quartz, which we are pulverising for the

* Dr. Ure. † Home paper.

‡ See article in Appendix on "Bricks and Tiles."

sole view of extracting the gold it contains. This may at some future period be eagerly sought after, not only for pottery, but also for the manufacture of glass. Flints are ground in Europe expressly for mixing with kaolin or china clay for pottery ware, and the glaze with which they are coated.

Earthenware from Sludge.—The very sludge of our gold-fields, on account of its present uselessness, has to be treated and disposed of at vast expense as an intolerable nuisance, may at some future period be sought after and used for earthenware. In the *Ballaarat Star,* in 1859, I found the following :—" We have seen some very nicely moulded and carefully burnt chimney pots made from sludge by a person near the cemetery. The specimen articles we inspected are beautifully smooth, of fine texture, and ring as soundly as a bell. Something will yet be made out of the 'sludge nuisance.'"

In England and other parts of the civilised world, clay is washed and made into bricks, tiles, and other earthenware, and even into highly valuable porcelain and china ; but in Victoria we wash with an equal amount of trouble, and at least double the expense, equally valuable clay, and throw it away, or rather *in our way,* and then expend thousands of pounds sterling to get rid of the "sludge nuisance."

As mentioned under the article "Bricks," natural clays, or clay fit for bricks or earthenware, without being mixed with any other material, is rare in England. In the case of the "sludge nuisance," we find, near the sources of the sludge, that it consists mainly of silica or sand, which is heavier than pure clay or alumina, and, therefore, subsides sooner ; but, if we follow down the sludge channel, we shall find that the proportion of sand to sludge, or liquid clay, is not so great, and at its *embouchere,* (unless the sludge has been agitated or stirred on purpose to cause it to hold the sand mechanically suspended, and thus carry it away) we shall find it to consist, for the most part, of finely pulverised washed clay, containing but little silica, or sand, and that little of the finest description. By simply washing, in a tumbler, and weighing samples of the clay or sludge in certain localities, we may ascertain the proportion the silica or sand bears to the alumina or clay, and mix it with other sludge or clay in such known proportions as are required for the article we intend manufacturing.

Victorian manufacture.—From the Blue-book for 1858, I find there were five potteries in the colony ; two of these were at

Melbourne, one at Ballaarat, one at Sandhurst, one at Preston, and the other at Geelong.

Hitherto we have manufactured such articles as bricks, tiles, drain-pipes, chimney and flower pots, pans, and other stoneware, or common red earthenware. We have not hitherto made any delftware or crockery, porcelain or china, although I suspect the greater part of the £63,000 worth of earthenware imported here in 1858, consisted chiefly of delftware or crockery, in addition to £11,500 worth of tobacco-pipes for our smoking community. We also imported, and paid in the same year, £6086 for earthenware drain-pipes.*

At our Exhibition, in 1854, were to be seen, fire-bricks and flower-pots, made at the Toorak potteries; and also, flower-pots, water-coolers, spirit-jars, drain-pipes, made at North Melbourne, of common earthenware or stoneware. This seems hitherto to have been the height of our ambition in the manufacture of pottery, being the only kind that can generally be made with natural clay, without the intermixture of ground flints, or, as a substitute, ground quartz, which would require flint or quartz mills to grind it even finer than it generally comes from the quartz-crushing machines.

High Rate of Wages here.—Although we have abundance of suitable material in Victoria for all kinds of pottery, not excepting crockeryware or delft, and porcelain, on account of the present high price of labor, we cannot compete with the imported articles in Melbourne, although we may do so at Ballaarat, Sandhurst, and other places where the carriage and breakage would considerably enhance the present prices in Melbourne.

Evidence given before the Tariff Committee in 1860.—From the evidence given before the Tariff Committee, on the 2nd March last, I learn that although the pipe-clay of Batman's Swamp is of the best kind for pipes, jars, bottles, pans, &c., that the proprietor of the potteries there could not compete with similar imported articles. The rate of wages for potters were nearly double, and for laborers employed in the potteries, about four times the rate paid in England; and that, earthenware pipes, pans, &c., being packed one inside the other, came out as ballast,

* In 1859 we imported chinaware to the value of £4888; earthenware £47,869; drain-pipes (chiefly of stoneware) £7280; tobacco-pipes, £7322.

for £1 per ton, or even less; that the retail price of coals was as high as £3 per ton in Melbourne, and at the potteries (near the coal-fields) in England, only 10s. per ton. It was also stated in evidence, that notwithstanding these great differences in the price of labor and fuel, six-inch drain pipes, *e.g.*, could be made here for about 25 per cent. more than the cost of importing them, but that small articles, such as ginger-beer bottles, on account of the greater proportion of labor to material, cost nearly three times as much, even when made with the assistance of a machine. The proprietor of the Flemington potteries stated that he could make one mile of drain-pipes per week, in his establishment, and that there were thousands of acres of clay here as good as at home. Another potter stated that the fire-bricks made here would stand fire, but not the cooling afterwards, and that the real fire-clay, equal to the English, was found at Cape Patterson, and that with the proper fire-clay, good fire-bricks could be made here for less than we could import them. It is very evident that the greatest drawback to the economical manufacture of pottery, and many other articles, near Melbourne, is the high rate of labor, and the high price of coals; although, in the case of pottery, it by no means follows, that potters should use coals, particularly when suitable firewood can be obtained at about one-third the cost. In France, wood is the only fuel used for burning every description of pottery, not excepting the renowned Sevres porcelain or china.

Preparation of Clays for Pottery.—The clay is freed from stones when dug, and is then puddled and tempered, the same as for brick-making; it is then worked up into earthenware, stoneware, &c., but even for this purpose, as before stated, natural clay of a suitable quality cannot always be obtained, and most clays are generally mixed with certain proportions of silica or sand; but for delft and porcelain, ground flints are added in suitable proportions, according to the quantity or proportion of silica in the *natural clay*. The flints are burnt or roasted in kilns, ground in flint mills, and sifted to different degrees of fineness, according to the quality of ware required, in the same manner that quartz is roasted and crushed on the gold-fields; and which, as before stated, would answer all the purposes of pottery and porcelain. This flint powder, fine silica or quartz, is further reduced by flint mills into an impalpable powder; both the clay and flint powder are reduced to a standard degree of fluidity, mixed in certain proportions, and

intimately incorporated by pug mills. The mixture is next freed from excess of moisture, by evaporating in *slipkilns*, which resemble salt pans of saltworks, and, like them, have furnaces beneath them. When brought to a proper consistency, the dough is removed from the troughs or pans into damp cellars, where it is kept several months, by which it is mellowed, and is better than new *paste* for any kind of ware. The mass is once more incorporated by sluicing machines, and also by cutting lumps of the *paste* into, and slapping them together, when it is fit for the potter's wheel.

Throwing consists of shaping the dough previously weighed for certain articles by placing it upon the centre of the potter's wheel, which revolves rapidly while the potter gives it the required circular form by manipulating with his hands, assisted by wooden pegs and gauges for the size required; he then cuts it off the wheel with a fine brass wire, when it is gradually dried until it has attained a certain consistency, called the green state; it is then nicely turned to its proper shape in the turning-lathe, and slightly burnished with a smooth steel surface. The wheels and lathes in large establishments are worked by machinery. The handles, and other appendages are next attached to the vessel or article; they are then taken to the stove-room and heated to 80° or 90° Fahr., by which means they are fully dried. Such articles as cannot be fashioned in the lathe are pressed through apertures of the required size, the worm, or pipe-shape dough, as it issues is cut to the proper length and bent to the desired form.

Casting consists of pouring liquid clay into moulds of plaster of Paris which absorbs the moisture from the outside of the article, when the inside, which remains liquid, is poured out, leaving a shell of the thickness required. The castings, ornaments, &c., are joined together by slip, or liquid clay cement. Imitations of flowers and foliage are made by hand and joined in this way, which is called furnishing. The articles, being now ready for the kiln, are placed in fire-clay boxes, or saggers, which are piled up in the kiln into columns called bungs. *The fuel* used for firing the kilns in England is coal, which is supplied from time to time, test pieces, called ball-watches, being used to determine the temperature, and to guide the degree and duration of the firing, which lasts from forty to forty-two hours, when the kiln is gradually cooled and emptied,

the articles being dipped into a glaze; they are then fired in the glaze-kiln for about fourteen hours to fix the glaze.

Glazes consist of white lead, red lead, ground flints, flint glass, feldspar, soda, nitre, borax, chalk, oxide of tin, &c.

Metallic lustre for outside use consists of a glaze composed of sixty parts of litharge, thirty-six feldspar, and fifteen ground flints.

Gold lustre, platina lustre, iron lustre, marbling, &c., may also be produced and applied for ornamentation.*

PORCELAIN.

Porcelain consists of a fusible with an infusible earth, which, when combined, are susceptible of becoming semi-vitrified and translucent in the kiln.

The biscuit of the hard porcelain made at Sevres is generally composed of kaolin clay and decomposed feldspar; the kaolin is washed at the pit and sent to Sevres under the name of *decanted earth.*

Kaolin and feldspar are found in large quantities in the granite formations of Victoria.†

Fuel.—The fuel used at Sevres is aspin and white-wood for porcelain, the glaze being ground feldspar mixed with a little vinegar; every article is put into a sagger by itself, as they must not touch each other; the saggers are composed of similar materials to those used for glass-house pots.

The firing continues altogether from thirty to thirty-six hours, about twelve times as much fuel being used than is required for stoneware. With forty cubic metres of wood 12,000 stoneware plates may be completely fired, both in the biscuit and glaze kilns, while the same quantity of wood would bake at most only 1000 plates of porcelain.

Glass-house pots (*see* glass) are composed of a pure fire-clay (the constituents of which are equal portions of alumina and

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* See article "Pottery," in Ure's Dictionary.

† The Victorian Government advertised for sale by tenders (in April, 1861) fifteen acres of kaolin or porcelain clay at Bulla Bulla, a post town eighteen miles from Melbourne, and from a letter headed "Resources of the Colony," which appeared in the *Argus* in February or March, 1861, I learn that works for the manufacture of porcelain, or chinaware, had been already established there.—C. Mayes, July 1, 1861.

silica, and in this respect resembles kaolin, which is disintegrated graphic granite, containing equal portions of feldspar and quartz), mixed with a fourth part of broken crucibles, or earthenware ground to powder.*

RUM.

The rum imported into Victoria in 1858 was valued at £70,519.†

Jamaica rum.—Rum is distilled from the fermented skimmings of the sugar-pans, or teaches, mixed with molasses and diluted with water to the proper degree. "The wort is made in Jamaica by adding to 1000 gallons of spent-wash, or dunder, 120 gallons of molasses, 720 gallons of *skimmings* (=120 molasses in sweetness) and 160 gallons of water, so that there may be in the liquid nearly 12 per cent. by weight of solid saccharum, or pure sugar."‡

Flavor of rum.—Spirits distilled from molasses do not contain the flavor of rum, the flavor of which is due to the large quantities of lees, or spent-wash, of former distillations. The fermentation goes on best in large masses, and requires from nine to fifteen days to complete the process. The quantity of rum produced is from four to five and a half gallons to each cwt. of sugar.

"*The wash* should be examined from day to day, and when it has reached its maximum strength, which can be ascertained by the hydrometer, it should at once be transferred to the still, and worked off by a proper-regulated heat (*see* alcohol); if it is allowed to stand over it will deteriorate by acetification."‡ The cane-juice, like the juice of grapes, will undergo spontaneous fermentation, but so slowly and irregularly that it is advantageous to quicken it by the addition of *dunder;* rum-distillers even soak woollen cloths in the yeast of fermenting vats to preserve the ferment from season to season. Sugar, if properly fermented, will yield its weight in proof spirit.

Sugar Refinery at Sandridge, near Melbourne.—A sugar refinery has been recently established at Sandridge in connection

* See Dr. Ure's Dictionary.

† In 1859 we imported rum to the value of £52,601.—C. Mayes, July 2, 1861.

‡ Dr. Ure.

with a distillery for the manufacture of rum, the only one of the kind in Victoria. There is a duty on all spirits distilled here from sugar of 9s. 3d. per gallon, and from grain 10s. per gallon.*

SALT.

Salt (culinary), or chloride of sodium, occurs in the form of rock salt in the saliferous or new red sandstone formation; the rock salt with the brine springs from it, affords the whole of the salt made in England. This formation is not known in Australia; we have therefore no rock salt here, but we have other sources of supply from our salt lakes and sea water. In 1858 we imported 5597 tons of salt, valued at £22,956, being about £4 per ton.†

Native salt is found on the shores of our salt lakes; it is very coarse (as all natural salt is) owing to the low temperature at which the salt water is evaporated. At Lake Hindmarsh it is found in vast quantities, and is very easy of access, as may be inferred from the fact that it is sold in the Ararat district at £3 per ton, being only a low charge for its cartage of about 100 miles on the Adelaide road. We have other salt lakes about 50 miles west of Geelong, the largest, Lake Korangamite, being about 100 square miles and Lake Colac about 20 square miles in area, besides many salt lagoons in this and other parts of Victoria, affording native salt already evaporated on their banks, the crystals being cubical, with their sides about $\frac{1}{16}$ of an inch in length.

Facilities for Manufacturing Salt.—With such vast quantities of native salt in several inland localities, all towns within say 50 miles of a salt lake might be supplied at a cheaper rate than from sea salt, obtained by the evaporation of sea water on our coasts. Salt from sea water is obtained by natural evaporation. The water is first retained in reservoirs constructed below the level of high water mark, in suitable localities, on the sea shore, the water being admitted by means of an inlet or open channel provided with sluice gates, by which it can be easily admitted and retained. In this reservoir its impurities may subside before it is allowed to flow

* In 1859 there were 4524½ gallons of rum distilled in Victoria.—C. Mayes, July 1, 1861.

† In 1859 we imported 8970 tons 18 cwt. of salt, valued at £42,606.—C. Mayes, July 1, 1861.

into brine-pits, which are divided by compartments, so as to be easily accessible for the purpose of raking the crude salt (left by evaporation) on to their sides.*

Brine-pits.—These brine-pits may be of any extent collectively, the object being to expose the largest amount of surface to the action of the sun and wind. Both the reservoir and brine-pits should be excavated in clay, or otherwise made impervious to water, or they would be likely to fill from fresh water land springs. Where clay forms the only lining, the salt derives its color from the color of the clay, and may be either brown, red, white, or grey, in which case it must be cleansed by boiling, and if quickly evaporated by proper salt-pans, will form fine table salt.* As this would probably be the description of salt generally required, there would be but little advantage in lining the reservoirs and brine-pits with either brick, paving tiles, or cement, which would add greatly to the cost of the excavation.

Purification of native salt.—Native salt is never found in a pure state, but contains from 1 to 7 per cent. of lime, magnesia, soda, oxide of iron, clay in a state of diffusion, &c. The chief of these impurities consists of magnesia, sea salt containing nearly nine parts in 1000, and twenty-five parts or $2\frac{1}{2}$ per cent. of pure salt; but sea water is easily purified and sweetened, by merely adding lime equal to the magnesia, or about 1 per cent. by weight of the water used, when it may be safely crystalised by rapid evaporation. The boilers constructed in Bavaria, at the salt-works of Rosenheim, consume 1 lb. of wood for every $3\frac{1}{2}$ lbs. of water evaporated, which is there considered a favorable result, but which might easily be increased to 5lbs. by a better arrangement of the furnace and evaporating pans.* Should salt-works be established in Victoria, (with the view of dissolving and rapidly evaporating, for table salt, our vast depositories of lake salt) it would probably be advisable to establish such works as near as practicable to any lake in a thickly wooded district. According to M. Gay Lussac, 100 parts of water at 62° Fahr. (which is not greater than the average temperature of water in Victoria during the summer months) will dissolve thirty-five parts of salt. Supposing our lake salt to be dissolved with this proportion of water, one pennyworth of wood, at 5s. per ton (the price if

* Dr. Ure.

obtained on the spot), will evaporate 150lbs. of water (reckoning only 4 lbs. of water to 1lb. of wood); this would be equal to at least 50 lbs. of salt contained in 150lbs. of water. At 10s. per ton (the wholesale price of firewood delivered in Melbourne), it would only cost one penny for fuel to evaporate 25 lbs. of fine table salt.

European manufacture.—In France and Germany sea water is pumped into immense cisterns, built upon lofty towers, called graduation houses, from which it descends between skeleton walls, filled with bundles of thorns or fagots of brush-wood, the object being to bring the water in contact with the largest surface, for the purpose of speedy evaporation by the wind and sun. At Salza, near Schönebeck, there is a *graduation house* 5817 feet long, the thorn walls of which are from 33 to 52 feet high, and present a total surface of 25,000 square feet, but the water has to be raised and passed through the thorn walls about ten times to increase its specific gravity 0·013, so that sea water of the specific gravity of 1·030 would only be increased to 1·043 by this tedious process, allowing that during our summer months only five falls of the same water would produce this result, it is questionable whether the same result could not be obtained more economically by brine-pits. The saturated solution of salt before referred to would be about 1·196, and would therefore not require much boiling to raise it to a specific gravity of 1·200, when it is fit to be transferred to the evaporating or finishing salt pans, which are very shallow, and present nearly the whole of their underside to the furnace and flues.

In addition to lime, which is added to the brine, to convert the chloride of magnesia into an available deposit of chloride of lime, it is usual in the boiling to add a little bullock's blood, by which the sediment is thrown down in clarifying.*

Sea Water contains about $2\frac{1}{2}$ per cent, or one-fortieth of its weight of chloride of sodium or pure salt, so that it would cost one penny for firewood, at 10s. per ton, to evaporate 80lbs. of sea water, yielding at least 2 lbs. of pure salt; this would be equal to a halfpenny per lb., or about one-fourth of the value of the salt per lb. imported in 1858.

With the slight difference in height between high and low water, and the porous nature of the ground on the north coast of

* Dr. Ure.

Hobson's Bay, it might not be considered advisable to excavate reservoirs and brine pits near Melbourne to evaporate sea water for the purpose of obtaining salt, but there are many suitable localities for such works, where wind-pumps, or pumps worked by wind, might be brought into use to raise sea water into reservoirs, whose surfaces might be above the high water level of the adjoining beach.

SOAP.

In 1858 we imported 151 tons of soap, valued at £8161, or about £54 per ton; and during the same year we exported 174 tons, valued at £6000, being about £34 per ton.* The Blue-book for 1858 does not furnish any clue to explain this great difference in the value of imported and colonial soap. The only kind of soap (as far as I have been able to ascertain) hitherto made in the colony is the common brown bar soap. The whole of the soft soap used in Victoria is imported, and as it is about three times the price of common hard soap, the difference in the value of our imported and exported soaps may thus be partially accounted for.

The number of soap-boiling establishments in Victoria in 1858 was eighteen, three of which were in Melbourne, four in Prahran, and about the same number in Footscray. As we export more soap than we import, we may regard the successful manufacture of common hard soaps at least as a *fait accompli*. This description of soap is made by boiling together a decoction of soda, called soda ley, and tallow. In 1858 we imported 975 tons of alkali, chiefly soda, the greater portion of which was probably used in the manufacture of hard soap.

I am at a loss to account for the non-manufacture of soft soap in Victoria, since potash, the alkali used in the manufacture of soft soap, is imported for other purposes. Both potash and soda might be manufactured in Victoria from the raw materials, which are disseminated in abundance (see articles "Potash," and "Soda"). Whale or cod oil is used with tallow in making soft soap, which may therefore easily be manufactured in Victoria, since it affords

* In 1859, we imported 335½ tons of soap, valued at £13,036, and exported 305½ tons (121½ tons of which were the produce of the colony) valued at £10,601.—C. Mayes.

all the raw materials required. Toilet soaps are made from purified hogs' lard, olive, almond, hemp-seed, and other oils saponified with soda ley, and perfumed with bergamot and other scents.

SODA.

Crude carbonate, or the soda-ash of commerce is used in the manufacture of glass and soap. Although it may be obtained here, it is questionable whether it could be made as cheaply as it is imported, viz , at about 2d. per pound, owing to an essential ingredient in the manufacture, sulphuric acid, not being procurable from our raw materials in sufficient quantity for commercial purposes. Taking it for granted that we must import sulphuric acid at about 3d. per pound, and that about eleven ounces mixed with about fourteen ounces of common salt is required to make one pound of sulphate of soda, which has to be converted into crude soda or soda-ash, valued at 2d. per pound, it is evident it will not pay, unless the muriatic gas evolved and condensed into muriatic acid during the process of mixing the salt and acid be of sufficient value to make up the absolute loss in the production of soda, as shown by the above calculation. To convert sulphate of soda into soda-ash, the following process is necessary:—

Process of manufacture.—To 100 parts sulphate of soda add 110 parts of carbonate of lime or pure limestone, and fifty-five parts of coal-dust, or fifty parts of powdered charcoal; this mixture must be well ground and mixed together; it is then incinerated upon the hearth of a reverberatory or decomposing furnace, where the sulphur is driven off in from one to five hours, according to the quantity or charge: a charge of about 200 pounds of the last named mixture requiring not more than one hour and one man to complete the process: the product will consist of 168 parts of crude soda = 56 dry carbonate from the above mixture of 260 or 265 parts.

The extraction of pure carbonate of soda from soda-ash is accomplished by mixing it with its own weight of saw-dust, coal-dust, or powdered charcoal, and incinerating the mixture in a reverberatory furnace. It takes three or four hours to complete the process, the heat being just above the melting heat of lead.*

* Dr. Ure.

STARCH.

In 1858 we imported starch to the value of £14,000. Ordinary starch may be made from wheat, barley, oats, maize, potatoes, &c. The starch of commerce is made chiefly from wheat and potatoes.

Wheat Starch.—Wheat produces from thirty-five to forty per cent. of good starch, therefore, if it is grown here at 1½d. per pound, or about 7s. per bushel, the starch produced therefrom would cost 4d. per pound for material only, the present wholesale price of starch in Melbourne. The waste or refuse being at least one-half of the wheat, should pay all expenses of manufacture if used or sold as pigs' food. "Wheat partly damaged by storage may be used, as the starch is not affected by such injury." * It may be used either ground or not ground, but in either case it is steeped in water for from fourteen to twenty days, when it is put into bags and subjected to hydraulic pressure; the water containing the starch in solution on being pressed out of the wet wheat, is washed and allowed to deposit its starch in large cisterns; this deposit or pap is passed through fine sieves; when sufficiently dried and firm it is broken up and fully dried in drying rooms which are heated by stoves in winter. It may be colored blue by the addition of smalt if required. As colonial oats were sold as low as 3s. 6d., and imported at 2s. 9d. per bushel, in Melbourne, during the year 1860, it would be cheaper to use oats for this purpose, being only about two-thirds the price of wheat, or 1d. per pound. Oats afford about the same quantity of starch as wheat does, both by chemical analysis yielding at least seventy per cent. of starch, by which it would appear that there is plenty of room for improvement in the mode of manufacture.

Starch from Potatoes.—Red and sweet potatoes each contain fifteen per cent.; English potatoes, thirteen; and kidney potatoes, only nine per cent. of pure starch, according to the tabular statement of Dr. Ure. Although not grown to any extent in Victoria, Mr. E. Dacomb, of Portland, has grown both the red and white variety of sweet potatoes, many of them weighing nearly three pounds each. Such a prolific crop is well worth cultivating, if it were only for the manufacture of starch. So far back as 1843, machinery driven by two horses was able to rasp and perform all

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* Dr. Ure.

other necessary operations in converting eighteen cwt. of potatoes into starch in one hour, including the pumping of the water required, the product in starch amounting to seventeen or eighteen per cent. of the potatoes. The quicker the process of making potato starch the better, on account of the great liability of potatoes to ferment when macerated.*

Potatoes can be grown here for about one halfpenny per pound; at this rate it would cost 3d. per pound for the materials of potato starch; the refuse, as with wheat starch, being equivalent in value as pigs' food for the cost of manufacture. Although potatoes may be grown at the above price, this will not include cartage. The starch mill may be used on the farm, the weight and consequently the carriage of the starch being only one-sixth the cost of the carriage of potatoes. It will thus be seen, that when the potatoes are grown at a great distance from a market, it may answer the purpose to convert them into starch, and thus save five-sixths of the cost of carriage.† In 1858 potatoes were imported here to the value of £107,540, although more than £12 per ton.

SUGAR.

In 1858 we imported raw sugar to the value of £543,000, and refined sugar to the value of £93,760, together upwards of £636,000; we have therefore ample scope for the growth of beetroot and its conversion into sugar, even to supply our own requirements in this respect.

Supposing we were to grow beetroot and manufacture sugar to this extent, we should only produce about one-eighth the quantity of sugar annually produced by France from beetroot. Dr. Ure states, that "the southern limit (in the northern hemisphere) is 45° of latitude for the successful cultivation of beetroot for the manufacture of sugar." From the report relating to the Experimental Farm I find that both sugar-beet and sorgho have yielded good crops, and are used in France and on the continent of Europe generally in the manufacture of sugar and spirits. Beet has not been grown to any extent in Victoria hitherto, only 8$\frac{3}{8}$

* Dr. Ure.

† From the *Argus* of the 26th April, 1861, I learn that a starch manufactory was about being established at Winter's Flat, near Castlemaine, which would be able to compete with imported starch.—C. Mayes, July 1, 1861.

acres having been cropped during the year ending 31st March, 1860, exclusive of that grown in market and kitchen gardens; but the fact, an important one, has been established, viz., that good crops have been and therefore may be again obtained here for the manufacture of sugar, if required for that purpose. In the manufacture of sugar from beet the root is grated by a grating machine, which obtains from 75 to 80 per cent. of juice; the amount of sugar obtained is only one-twentieth of the weight of the root, one ton of beet being required to produce one cwt. of sugar. The pulp obtained by the grating machine is put into bags and subjected to hydraulic pressure; the juice thus obtained is purified by adding one pound of lime to eighty gallons of expressed juice, which is filtered through blankets, concentrated by boiling, and again filtered, but this time through bone black or animal charcoal; it is next evaporated in swing pans over a brisk fire in quantities equivalent to half a cwt. of sugar, or four hectolitres of average juice.*

Sugar refining.—As before stated we imported refined sugar to the value of £93,760 in 1858. Without entering into the process of refining sugar, it will be I think sufficient to state that a sugar-refinery was established at Sydney some years ago and was found so remunerative that a similar refinery has been recently (1858) erected at Sandridge, in connection with a distillery, for the economical application of the molasses obtained from raw sugar, equal to about one-fifth of the sugar refined, which is taxed by the Government to the extent of 7s. per cwt.

Sugar cane.—The cultivation of the sugar-cane succeeds best at a mean temperature of about 76°, and may be successfully cultivated with an average temperature of not less than 67°, which is probably higher than the average temperature of the north-west boundary of Victoria, although not so much so as to warrant no trial being made on the banks of the Murray below the confluence of the Loddon river. The mean temperature of Melbourne is 59½°.

I have seen much information at various times upon the cultivation of the sorghum saccharatum for the manufacture of sugar, and am aware it is very much liked as green fodder by our cattle: as before stated it has, like sugar-beet, yielded good crops here. Maize has also been successfully grown in Victoria (*see* Paper);

* Dr. Ure.

like the other cereals it contains a considerable quantity of sugar in its stem, which may be extracted as from the sugar-cane.

TIN.

In 1858 we imported forty-seven tons of tin, besides tin-ware, tin-foil, and sheet-tin, valued together at £25,770; during the same year we exported 358 tons of black sand valued at £19,600, or about £54 per ton. There has not been so much as this exported since, probably on account of the operations of the Victoria tin smelting company who have established works in William-street, Melbourne, since March or February, 1860; my informant, who writes in the *Colonial Mining Journal* for March 1860, says, "We were agreeably surprised to find the works in operation, and the tin in ingots lying in quantities. The establishment of these works has been of great service to the Ovens miners, who now get the full value of the black sand. The company will be able to compete with the home market, and we believe a large trade with the neighboring colonies and India will follow."

Charcoal Sheet Iron and Tin Plate.—The best sheet-iron (which when tinned is called tin-plate) is made from charcoal iron (*see* Iron), which can be advantageously made from our hæmatitic iron ores and excellent charcoal, and now that we have tin-works might be profitably tinned here, large quantities of tin-plate or sheet-tin being used in Victoria for the manufacture of tin-ware. In 1858 we imported sheet-tin to the value of £11,762. From the evidence given by tinsmiths before the Tariff Committee on the 2nd March, 1860, I learn that "our tin smiths can compete with imported bulky articles on account of the high charge for freight, but not without the aid of machinery; that only the common and not the better class of articles are got up here; that tea-kettles and coffee-pots are made in England and Victoria too by females; and that a family of children make such articles in Richmond."

TOBACCO.

The duty, at 2s. per lb., upon tobacco imported in 1858 was £132,381, of which £108,327 was for American. During the year ending 31st March, 1860, there were 387 cwt. of tobacco

grown in Victoria, the average produce being about thirteen cwt. per acre, showing an increase of three cwt. per acre over the produce of 1858; but these average crops are capable of being extended to 20 cwt. per acre when properly cultivated with suitable seed. It is considered a profitable crop in New South Wales and should be so here, the latitude of Victoria being the same as Virginia, where it forms an important article of commerce. From the evidence given to the Tariff Committee in February and March 1860, by tobacconists and growers of tobacco, I learn that the Australian is better for twist and as good for leaf tobacco as the American, but the generality of it is mixed with imported tobacco. The cost of manufacturing tobacco here is only sixpence per pound; the cost of producing the raw material may be estimated from the fact that two men can cultivate three acres, and could also pluck and prepare the leaf from June to February ready for manufacturing. Large quantities of tobacco of an inferior description is imported and used for sheepwash, which might be grown here for one-third or one-fourth less than the imported price.

The tobacco hitherto grown in Victoria has been inferior to that grown in New South Wales, where it pays the farmers to grow it at fourpence per pound, but here it costs eightpence. It is easily grown, children can pluck the shoots from the plants, or nip off the top of the stem, to throw all the strength into the leaves, as well or better than men. The best sample of tobacco hitherto grown in Victoria is that for which Mr. Christie, C.E., obtained the prize at the Horticultural show; it was grown from Havannah seed, and could be profitably manufactured into cigars; it is lighter in weight than the other kinds of tobacco, and is worth from one to two shillings per pound. All other tobacco hitherto grown in Victoria is believed to be from American seed, and as it is inferior to that produced by Mr. Christie, the cultivation of tobacco from Havannah seed is well worthy of our consideration. The witnesses examined by the Tariff Committee agreed that if the duty was reduced on raw or unmanufactured tobacco, that the manufacture of cigars in Victoria would give employment to several hundred men, women, and children, and that there were at present at least 200 cigar makers in the colony.

In 1858 we imported cigars to the value of £57,537, exclusive of the tobacco before referred to.

Our tobacco and cigar manufacturers have not been able to

compete with the imported article because our Victorian tobacco, hitherto, with a few exceptions, has not been of the quality required; but since Mr. Christie has proved the practicability of growing the best description of tobacco, it seems only necessary to grow similar tobacco from seed of a similar kind to produce tobacco here equal to any imported, and thus give employment to our cigar makers, besides numerous women and children. "Thousands are employed at home manufacturing tobacco from the imported leaf, because every man requires three or four boys to help him."

"A good cigar-maker can make 1000 best, and from 2000 to 3000 common cigars per week; 20 lbs. of tobacco will make about 13 lbs. of *regalia* cigars, the remaining 7 lbs. is in the form of stalks and dust which, although generally sold at a reduced price for sheepwash, could be made into snuff."

VINEGAR.

Vinegar is produced by the fermentation of alcoholic drinks, and all alcoholic liquors are produced by the fermentation of saccharine matter or sugar.

Acetic Acid.—The essence or sour principle of vinegar is called acetic acid, and this may be made from any kind of alcoholic liquor, or from alcohol itself. In Germany, where it is cheap and plentiful, large quantities are converted into acetic acid; but as alcohol can be applied to so many other equally useful purposes in Victoria, it is not likely to be used for this purpose, since acetic acid may be made from brandy, rum, gin, or any other spirits; and should the manufacture of spirits be ever carried on in Victoria to any great extent, the bad spirits only are likely to be used for this purpose.

Vinegar.—The time required to convert any alcoholic liquor into vinegar depends simply upon the quantity of oxygen or common air that can be introduced into it; for this end it is best placed in shallow vessels, so that a large surface may be exposed. Acetification is most rapidly produced by a vessel called a *graduator,* which may be a cask standing on end and partially (about one-fourth) filled with the liquor required to be acetified, the whole of the cask being loosely filled with loose brushwood, string, or any light innocuous substance through which the air may

permeate and by which the liquor may rise and fall by capillary attraction; the cask or vessel is perforated with holes just above the liquor and also a little below the loose head or cover which is required merely to throw off the rain, if in the open air; by means of the ventilating holes currents of air are introduced throughout the vessel and acetification takes place, sometimes in two, but the general period required is about twenty days. The acetification in this instance, as in all vinegar manufactories, being merely the result of the second or acetous fermentation, may be promoted by the introduction of vinegar or the scum called *mother* which rises during the acetous, and acts in the same manner as yeast in promoting the first or vinous, fermentation in ale, &c.

The temperature required may vary between 60° and 90°; if it is either below 60° or above 90° the acetification ceases. During the process of the acetous, the liquor rises in temperature as in the vinous fermentation, and a peculiar aromatic vapor is evolved; this continues until the whole of the alcohol is changed into acetic acid, when it falls to the temperature of the surrounding air.*

Having stated the principal facts to be borne in mind, with the mode of operation to be pursued in the manufacture of vinegar, it will be seen that this colony offers equal facilities with any other country, since the process is so simple as to be easily understood, and requires apparatus obtainable in any civilized country.

The particular kinds of vinegar likely to be made in this colony are—1, wine vinegar; 2, malt vinegar; 3, sugar vinegar.

1. *Wine Vinegar.*—As Victoria is likely to become a wine-producing colony, and as a large quantity of this wine may become sour, especially during the first few years, I will proceed to show how easily it may be turned to the best advantage by being completely acetified or converted into vinegar. I have already stated the general process, which is applicable to all kinds of vinegar-making. On account of a certain even temperature being required, it is necessary to prevent loss of time that this temperature should be preserved by a good fermenting room, capable of being warmed by flues in the winter. The rapid absorption of oxygen or vital air, especially when the *graduator* is used, renders it necessary that the fermenting room should be well

* Dr. Ure.

ventilated; and, if not warmed, that the ventilating holes should be closed in cold weather to keep up the temperature.

The room, if heated to about 105° Fahr., will produce a heat in the *graduators* of about 77°, which is found to promote rapid acetification without injury to the vinegar. The upper part of the room is always the hottest, and the upper vats or vessels are most brisk in their operations. A supply of warm *wash* is kept near the ceiling, which may consist of either *mother* or good vinegar which is mixed with the alcoholic drink to be acidified; there are means of ascertaining when the acidification is complete.* Without entering into further details, my object is simply to show that the general principles of vinegar-making are simple and easily understood, and that our sour wine may be made the subject of an important manufacture.—[See *Wine.*]

2. *Malt Vinegar.*—Most of the British vinegar is made from malt wine or beer without hops; but that imported in the form of pickles, although called malt vinegar, is only wood vinegar or *Pyroligneous acid* (which *see* at the end of article on "Gas"). Although malt liquor is made expressly for vinegar, it must first become alcoholic or intoxicating before it can be acetified. These processes may be hurried by greater heat than would be deemed requisite, or even advisable, in the manufacture of ale or wine; yet I know of no system by which unfermented saccharine can be converted immediately into vinegar without being first changed into alcoholic fluids. By the ordinary methods three months are required to make good malt vinegar, but by using the *graduator* for the second fermentation this time may be much shortened. Wine vinegar differs from that made from corn, cider, sugar, &c., on account of the tartar extracted from the grape stones; but these may be introduced into the malt wine, or crude tartar may be added.*

3. *Sugar Vinegar.*—Vinegar may also be made from sugar, but as this is not a raw material raised in the colony, I shall merely add that vinegar may be made from any liquor containing alcohol, and that alcohol may be engendered in any liquor containing sugar or saccharine, and that saccharine can be produced in any grain containing starch by simply steeping and drying as with malt.

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* Dr. Ure.

The quantity of vinegar imported into this colony in 1858 was about 75,000 gallons, valued at £9300. The nett profit in England by the annual produce of 100,000 gallons of malt vinegar, as stated by Dr. Ure, is £1409.

After writing the above I met with the "Evidence given to Select Committee on the Licensed Publicans Act," where W. Hull, Esq, J.P., states that the ale sent here from England, although good when shipped, is often damaged on the voyage, or even after being landed, before it leaves the merchant's hands: this ale will make splendid vinegar." * * "I believe that those *pricked* (sour) beers are used by the brewers here to get up their own making more quickly; they have not capital to hold." He proceeds to say—"Beer that is *pricked*, however much it may be doctored by the publican, nauseates the palate;" and, in the previous answer, "All the vinegar that I have used at my house for the last two years I have made myself from this beer."

WHISKEY.

Whiskey is the name given to ardent spirits produced from grain, potatoes, &c.

In 1858 we imported whiskey to the value of £40,466.* "Wheat produces from 40 to 45 per cent of (its weight in) proof spirit; barley, 40 per cent.; rye, 36 to 42 per cent; oats, 36; and maize, 40 lbs. of spirit from 100 lbs., which is about the average produce of corn. Barley and rye are generally employed for making whiskey. It is deemed preferable to use a mixture of different grain, as wheat with barley and oats, or barley with rye and wheat. When barley is the only grain used, about 25 per cent. of malt is mixed with it; but when wheat and rye are added, about one-twelfth of barley malt is sufficient. Oats are well adapted for mixing with wheat, to keep the meal open in the mashing. The malt should be steam dried, except the smoky flavor called peat-reek is required, when it should be dried by a peat fire, or the whiskey itself may be impregnated with peat smoke, as is now often done. In 1843, when malt was 5s. per bushel in Scotland, the cost of whiskey distilled there was about 3s. per gallon."†

* In 1859 we imported whiskey to the value of £91,827.—C. Mayes, July 2, 1861.

† Dr. Ure.

Potato Whiskey is made from potatoes boiled with steam in a close vessel, and mashed into a homogeneous paste before they get cold. The paste is next triturated by a hand-machine, which triturates 1200 lbs. per hour; which must be forthwith mashed with some ground wheat or barley, and a small proportion of malt, and then set to ferment. As potatoes readily pass into the acetous fermentation, the mixing, mashing, and cooling should be rapidly performed.

The fermentation is brisk, and furnishes a good head of barm, which answers well for the bakers; 100 lbs. of fresh dug potatoes yield about 16 lbs. or $1\frac{4}{5}$ gallon of proof spirits, but if they have sprouted they will yield very little spirit.*

WINE.

In 1858, we imported wine to the value of £269,432, £187,805 of which was direct from Great Britain, although not supposed to be manufactured there.†

From the great attention lately paid to the cultivation of the vine and manufacture of wine, there can be but little doubt entertained of Victoria becoming in a few years an important wine-producing colony. This result is almost inevitable from the high opinion generally entertained of the superiority of Australian wine already produced in this or the neighboring colony of New South Wales, and the high encomiums showered upon it by competent judges in both England and France. "At the Exhibition, in Paris, of wines from all parts of the world, it found few rivals, and was enthusiastically declared to be generous, peculiar (Australian), rich, and full of beauties which develop with age." (*Australian Almanac*, 1857).

Judging from the progress already made by Victoria in the manufacture of wine, she will soon equal, if not outstrip, New South Wales as a wine producing colony. During the year ending 31st March, 1860, we manufactured 13,954 gallons of wine, being an increase of 6214 gallons made in 1858. From the "Report of the Agricultural Association of the Ovens and Murray District" I learn that "Vineyards only 6 years old have yielded at

* Dr Ure.

† In 1859 we imported wine to the value of £342,613.—C. Mayes, July 2, 1861.

the rate of 500 gallons of wine to the acre, and vines of 3 years old have produced twelve pounds weight of grapes to each vine. An experienced vine grower compares our plants at the age of 3 years to those of 7 years' growth on the Rhine." From such encouraging reports we may reasonably expect great results.

The value of the wine annually produced in France is from £32,000,000 to £40,000,000, and upwards of 3,000,000 persons are employed in the production.

As Victoria is naturally a wine-producing country, it is not unlikely that we shall eventually produce an equal quantity as compared with the population of France. The manufacture of wine is beginning to be understood in Victoria through the ventilation given to the subject by our local journals, assisted by a pamphlet or two, published here. The details of wine making may vary throughout the world, but certain principles must always be attended to in order to insure success.

The grapes should be fully ripe, or rather over ripe, and also quite dry, when they are gathered.

A layer of grapes should then be thrown into a vat, or cistern of wood, and trod out, or otherwise macerated; the must, or juice, with the husks and stalks, are next put into the fermenting tun, or cask, where they will readily ferment without the addition of yeast or any other leaven, the rapidity of the fermentation depending upon the temperature of the air, which should not be too hot, or the must will be apt to acidify. The fermentation, in summer, will be active, or even violent, rising the liquor in the vat; this should continue until it loses much of its sweetness, when it should be drawn off into the ripening tun, the lees and *marc* of the grapes being pressed, and the liquor, which contains a considerable quantity of *tannin*, added to the wine. This liquor has the same effect upon the wine as hops on beer, viz., enables it to keep better and longer.

It is absolutely necessary that the ripening tun should be kept quite full, and in a cool place, otherwise there is considerable risk of the wine turning sour. The cask should also be allowed to overflow through the bung hole on the top, if it has a tendency that way, and should be filled up, from time to time, as long as the fermentation continues active; when it has apparently left off fermenting, a small bag of sand should be placed over the bung hole, to allow any further escape of the generated gas.

In about a month after the grapes were crushed, the sand bag should be replaced by a bung, surrounded with a piece of canvas, which should be driven tightly into the cask. The wine may now be considered made, and only requires to be kept cool (for a year at least) to ripen. If it cannot be kept in a well-closed underground cellar, it should be buried, since it cannot be safely kept in the wood during the summer, but must in this case be bottled off at the approach of spring, generally some time in August. The return of warm weather will induce a secondary fermentation, and the wine will sparkle, when drawn, in proportion to the amount of saccharine matter not hitherto converted into spirit of wine.

In making wine in considerable quantities, underground cellars for ripening the wine will be found indispensable.

WIRE.

Wire is produced by drawing metal rods through a steel plate pierced with tapered holes regularly graduated in size from the largest to the smallest gauge; this is fixed upon a draw-bench supporting the machinery, which is very simple and effective, and may be worked by either one or two men. "The metal requires to be annealed now and then between successive drawings, otherwise it would become too hard and brittle for further extension; it is also well supplied with wax for the smaller, and grease for the larger wires while drawing. Iron and brass wire of one-third of an inch in diameter can be drawn at the rate of from twelve to fifteen inches per second, but when one-fortieth of an inch in diameter, at the rate of from forty to forty-five inches in the same time. Wire by being diminished one-half, one-third, &c. in diameter, is increased in length four or nine times respectively." * Iron wire was imported here in 1858 to the value of £12,630.† When we take into account the high rate of freight for so bulky an article as wire, (generally imported in large circular coils) in conjunction with the fact that it is made by machinery, it seems probable we may compete with imported wire of all kinds.

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* Dr. Ure.

† In 1859 we imported iron wire to the value of £20,676.—C. Mayes, June 29, 1861.

WOOLLENS.

In 1858 we imported woollens to the value of £226,663, and hosiery to the value of £71,259, to which may be added say half the wearing apparel and slops, equal to £230,000, making a total of about £528,000, exclusive of drapery, hats and caps, &c., which also include preparations of wool. Against this wholesale expenditure in imported woollen goods, we exported in the same year wool to the amount of £1,678,290, being 21,515,958 lbs., at about 18½d. per lb. Next to gold this is the chief article exported from the colony. It will be seen above that we import woollen goods to the value of upwards of half a million sterling; and as we have the raw material at hand in great abundance, it is really important that we should endeavor to manufacture some of those imported goods. An idea of the processes necessary to convert wool into woollens may be gleaned from the following:—

The wool is separated according to the quality required for different articles; the long wool is next separated from the short wool, the two kinds being used for different purposes requiring different treatment, the short wool being used for cloth, flannel, blanketing, &c., and the long wool for hosiery, *mousseline-de-laine*, and other open fabrics.

The long wool was formerly *combed* and straightened by men, but for the last thirty years it has been done by machinery, attended by children, by which means "the cheap and tractable labor of children is substituted for the high priced and often refractory workmen, too prone to capricious combinations." This remark of Dr. Ure is particularly applicable to our colonial manufactures, and shows the advantage of machine over hand labor.

All worsted and hosiery is made from the long wool, which is spun into a continuous thread and knitted by machinery, such as the plain and ribbed *"stocking frames;"* this is different to the weaving of cloth, which has two distinct threads crossing each other at right angles, and known as the *warp* and the *weft.*

Short wool for cloth is cleaned by machinery: it is passed through a machine called a *willy* several times and embued with oil; the wool is then *carded,* or straightened by machinery; the *slubbing* machine reduces the *cardings* into cord, sometimes called *rovings,* which is next spun into yarn or cloth by means of a *mule*

or *jenny,* which will also spin the finest *mousseline-de-laine* fabrics; the cloth is next *fulled,* by which means it is reduced to about half its breadth and two-thirds of its length, and is consequently very much thickened.

Teasling with thistles.—The next process is called *teasling,* which consists of raising the loose ends of the filaments and leaving the body of them entangled in the cloth. It is done by machinery, with the heads of thistles strung on a frame; the thistles were abandoned, not because any better substitute has ever been invented, but simply because the thistle heads became scarce in the neighborhood of cloth mills.* In the event of cloth mills being established here, even the "thistle nuisance" might be abated; nor is this the only use to which thistles can be applied: by referring to the article on "Potash," it will be seen that ripe thistles furnish the largest per-centage of potash excepting *wine lees.*

Cropping, or shearing off the filaments brought up by *teasling,* is also done by machinery, as well as the last operation, viz., imparting a lustre to cloth by passing it through hot water.*

Sydney Tweed.—It will be seen from the above imperfect description of the processes wool undergoes for conversion into woollen goods, that it is chiefly the work of machinery; and, as we might have expected, our enterprising neighbors of New South Wales have successfully competed with the importation of cloth by the manufacture of Sydney tweed. From the evidence given before the Tariff Committee, in February last, I learn that "Sydney tweed made in New South Wales is cheaper here than imported tweed of the same quality: it is made entirely of wool, and is therefore more durable than English tweed, which is more than half cotton." Sydney tweed was largely used in Victoria "before the gold-fields were discovered," which I imagine drained off the workpeople from the cloth mills, but now the *fever of gold-digging* has somewhat abated, it is again coming into more general use. In making tweed here we should save twelve months' loss of time and interest of money, also two or three merchants and brokers' profits, and the two freights, which has been found to equalise the cost of tweeds made in England and New South Wales. The gentleman who gave this evidence to the Tariff

* Dr. Ure.

Committee also stated "that he expected tweeds to be made here in two or three weeks." It is now eight months since, and I have heard nothing of any cloth mills being established in Victoria; such an event would be too important to be kept quiet.*

"CIVIL ENGINEER."

September 30*th*, 1860.

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* On the 14th January, 1861, Messrs. Alexander Donaldson, E. Lush, and Colin Brown applied to the President of the Board of Land and Works for a grant or a long lease on moderate terms of eight acres of land contiguous to the waterfall in the Yarra, in Studley Park, where they contemplated investing at least £15,000 in establishing a factory for the manufacture of woollen cloth, by which means they would afford employment not only to the numerous weavers, but also to vagrant children, whose time was not only lost to the community, but who helped to swell our rapidly increasing juvenile criminal list. These enterprising gentlemen met with no encouragement from the head of the Lands Department, who considered it his duty to resist any further appropriation of the public reserves in the vicinity of Melbourne. (*See Argus*, 15th January, 1861.) It may be considered desirable to make an application for say one acre of the waste land on the south side of the Yarra falls, in Melbourne, or for a supply of the superabundant water from the Yan Yean, at a nominal rate; in the last case the projectors would have considerable latitude in their choice of a site, contiguous to the line of pipes.—C. MAYES, July 1, 1861.

APPENDIX.

ANTIMONY.

In the *McIvor News* about the 1st April, 1861, there is an account of a rich reef of antimony of great purity, discovered on a station at the Wappingtack, 8 miles from Heathcote. Several blocks of antimony weighing from 2 to 7 cwt. each, were obtained within a week after the discovery, and the account also states that the same line of reef has been opened up a mile nearer to the township, the indications of which are better than the first. This appears to be sulphuret of antimony, from which about 75 per cent. of the antimony of commerce may be obtained, the remainder being sulphur.—*See the Introduction to this Essay.*

Since the above announcement there have been several confirmatory statements of the continued richness of these antimony reef which are so extensive as to lead me to suppose that antimony will henceforth be among the list of our raw materials. It need not be shipped to be smelted, since it can be reduced by liquation, the method pursued at Malbosc, in the department of Ardèche in France; this process consists in sweating out by a regulated heat, from an alloy (in this instance of sulphur and antimony) an easily fusible metal from the interstices of a metal difficult of fusion. Lead and antimony are the metals most commonly subjected to liquation. The ore is placed in luted iron crucibles, which are charged every three hours, and when properly worked, 100 lbs. of antimony is obtained every hour. The above operation is remarkable for the small consumption of fuel, the economy of labor, and the complete exhaustion of the ore. *

Antimony forms part of the alloys of type metal, stereotype metal, music plate, and Britannia metal.

BRICKS AND TILES.

In 1859, we imported 125,000 building bricks, valued at from 36s. to £10 per 1000, the former from Memel and the latter from Hamburg. In the same year we also imported 136,624 firebricks, of these there were 37,000 from the United Kingdom, valued at £13, and 5000 from South Australia, valued at £14 per 1000. The high priced bricks were doubtless of the

* Dr. Ure.

first quality, since I also find 10,000 firebricks from Stettin (a port of the Baltic) among the list, valued at only £3 per 1000.

Hitherto we have not succeeded in making first class firebricks in Victoria, at least I have heard of none equal to the best English firebricks, most of those made here will stand any amount of heat, but will not stand cooling, an essential property in all such bricks. A sample firebrick was shown to me lately at the Collingwood Gasworks, made by Mr. Stirling, in Simpson's Road, East Collingwood, which in density, appearance and texture was more like a Staffordshire or Glasgow firebrick than any other I have hitherto seen.*

In the manufacture of ordinary colonial bricks we have a great need of economy. In consequence of the high price of labor in Victoria, machinery might be brought into use with greater advantage as compared with the cost of manual labor than in any other part of the world. *As a rule, one pounds worth of firewood in Victoria will raise steam equal to that raised by the same value of coal in England.*

Brick machines capable of tempering clay and turning out 1000 bricks per hour have been made in England and exported here, where they have been badly worked by horse-power to but little advantage. With a portable engine such machines might be made very efficient, and by a detailed estimate I find we might manufacture good bricks at 30s. per 1000, including 25 per cent. for wear and tear, interest on outlay and profit—were the machine to excavate the clay, the cost might be still further reduced.

Excellent bricks are made at Philipstown, Brunswick, Northcote, and Hawthorn, all within 3 or 4 miles of Melbourne. They are heavier although not larger than the English bricks, and weigh from 3 tons and upwards per 1000; the carriage from either of the above places is therefore seldom less than 12s. per 1000 including loading, unloading, and stacking. In the case of Hawthorn this might be considerably reduced, on account of the inexhaustible supplies of superior brick earth to be obtained contiguous to the Melbourne and Suburban Railway, and its contemplated extention towards Kew. By means of short tramways the company's trucks could be loaded at the kiln, each truck containing two or three portable dray bodies to contain 400 bricks each, which could be lifted on to a suitable dray frame (with shafts, wheels, and axle complete) by means of a crane at the Melbourne terminus. By connecting the Melbourne and Surburban with the Hobson's Bay Railway, the bricks might be unloaded from the railway trucks at either Emerald Hill or Sandridge, at a slight additional cost for carriage by rail. Unless railways can be used in this way they are of no advantage for goods traffic except in long distances, because the extra cost of twice instead of once loading and unloading is greater than the

* Samples of these bricks may now be seen at the Exhibition, with certificates from the Engineer of the Melbourne Gas Works and Mr. Fulton, to the effect that they had put the bricks to the most severe tests, and found them equal to the best imported firebricks. With the bricks may also be seen samples of fire tiles, crucibles, &c., made at the same works.—C. Mayes, 4th November, 1861.

saving in the carriage by rail; the facility with which 25 or 30 cwt. is removed a few yards with a crane is well known.

An enterprising firm or company who could deliver good bricks into Melbourne at about £2 per 1000 would doubtless soon command the whole of the market, and would also tend to give an impetus to building generally; that such a result could be easily achieved is capable of demonstration, and may occur to any one who understands the subject.

TILES.

The few tiles that have been imported into Victoria are probably included under the head of building materials, as tiles are not mentioned. The best substitute for tiles are slates, which were imported in 1859 to the value of £33,954.

Patent Tile Company.—On the 7th January, 1859, Mr. Joseph Curet obtained a patent in Victoria for improvements in the manufacture of tiles; this patent has been purchased by the above company, who have made tiles (similar to the Marseilles tile), a sample of which may be seen on the roof of the Building Museum, in Queen Street, Melbourne. I have seen and examined a sample of these tiles, and consider them in color, texture, and density equal to the English roofing tiles, but they are made with rolls and have too little lap for our low-pitched roofs, otherwise they seem to be much liked and are highly spoken of in testimonials (from Melbourne architects) at the foot of the prospectus I have now before me. The slight defect of insufficient lap will be easily remedied, and from the general preference shown for tiles instead of slates I have no doubt they would soon come into general use. Although much heavier and dearer than Countess slates in proportion to their size, yet from the manner they are used in roofing, a *square* of these tiles weighs less and costs less than a *square* of Countess slating.*

Paving Tiles have not hitherto been made in Victoria as a marketable article. The many uses to which this description of tiles are applied throughout Great Britain, and to which they might be applied in this colony renders it desirable that they should be manufactured here, where we possess equitable materials for this and other descriptions of common earthenware.*

Fire Tiles made with the same materials as firebricks are also much required in Victoria for ovens, cooking ranges, furnaces, &c. Vast quantities of fire tiles and a similar material made into large blocks, called *Welch Lumps*, are sent from Wales into London and other parts of Great Britain, to be used in furnaces, fireplaces, &c.

BUTTER.

In 1859 we imported 3437 tons of butter, valued at £480,258, which is about 1s. 3d. per lb., showing an increase over the quantity imported in 1858

* Other descriptions of roofing tiles, also paving tiles, may now be seen in the Exhibition.—C. Mayes, 4th November, 1861.

of 1318 tons, and a decrease in the value of about 1d. per lb. At the same time we find this enormous increase in the importation of butter, of about 38 per cent., we also ascertain from our Statistics for 1859 that there were no less than 2,656,880 acres of purchased land in Victoria uncultivated, 967,515 acres of which was not even enclosed, and at the same time we had only 358,728 acres under cultivation.

Australian Produce.—In 1859 we imported butter not only from the United Kingdom, but also from Denmark and Hamburgh; these being old established kingdoms we might reasonably have expected this as a result of the low rate of wages, but when we also find that the adjoining colonies of New South Wales, New Zealand, South Australia, and Tasmania, together exported butter in 1859 to the value of £75,072, we may reasonably enquire how it happens that these colonies, laboring under the same disadvantage of high priced labor, and under other similar circumstances, should be able to export butter while we pay nearly half a million annually for the importation of this very article which we might produce ourselves, since it has been sold lately at prices likely to compete with the price of imported butter; as might have been expected the demand for fresh butter has generally far exceeded the scanty supply.

The wholesale value of the butter imported in 1858 and 1859 was from 1s. 3d. to 1s. 4d. per lb; but in consequence of the absurd custom of the exporters of butter allowing only for about one-half the actual tare, the retail price, with only a reasonable profit, has often exceeded the price of our own fresh butter. How long this anomalous state of our colonial pastoral interests is to be tolerated, will depend greatly on the expected increase of emigration, and the facilities offered to men of small means to establish dairy farms throughout the colony.

Dairy homesteads should possess suitable dairies, buildings, or cellars, in which both the milk and butter can be kept at a proper temperature throughout the year. In the manufacture of butter, the proper temperature has been variously stated to be from 54 to 62 degrees, by Fahrenheit's (now the ordinary) thermometer.

Thermometer Churns.—Patent churns are imported here from America, called thermometer churns, to which a small thermometer is attached, but in such a position that it cannot be read after the process of churning is began. The face of the glass tube is soon obscured by the application of hot water to the outer casing of the churn, combined with the process of churning. The secret or art of the rapid conversion of cream into butter rests mainly upon a certain temperature being observed, stated by the Patentee of these churns to be 62 degrees: this can be readily determined by a common thermometer applied to any churn.

Johnson's Patent Churn.—The butter of cream, and even new milk, is contained in small globules or sacs, which must be broken before they can be properly combined or agglutinated; this desideratum was rapidly achieved by Johnson's Patent American Churn, which was brought into use throughout the States about two years ago, where it has since been extensively patronised. In this churn the milk or cream is passed between rollers, which break the small bags of oleaginous matter forming the butter;

it is then manufactured or churned in a few minutes, if the proper temperature of about 62 degrees is observed throughout the operation. It thus appears that the object to be first accomplished in all churns, is to bring the milk or cream to the proper temperature, and then to break these little bags or globules ; this has been generally done by concussion, but it is more effectually and sooner accomplished by the milk or cream being passed between rollers. It is not generally known that new milk may be churned without the trouble of setting and skimming it to obtain cream in the usual manner.

Temperature.—By referring to the original article on Butter, it will be seen, on the authority of Dr. Ure, that butter is soonest produced from cream when at a temperature of from 53 to 57 degrees Fahrenheit. I cannot explain the discrepancy between so high an authority and the Patentees of the Thermometer Churn ; but as I know parties who have used this description of churn and have had no difficulty in producing butter at 62 degrees in a short time, I am disposed to think that the latter is the best temperature.

CEMENT.

In 1859 we imported cement to the value of £13,593, being £2387 in excess of the previous year, although the quantity was less in 1859 by seventy-three tons ; its estimated value being about £6 13s. per ton in 1858, and about £8 8s. per ton in 1859 ; the average invoiced value of all cement imported in 1858 and 1859 being about £7 10s. 6d. per ton.

I have already shewn in the original article on this subject, that we possess an abundance of raw materials suitable for the manufacture of cement of many kinds ; and after having studied the subject both theoretically and practically for many years, I am at a loss to know why cement manufactured in Victoria should not be equal to any that has hitherto been imported.

Mr. T. Edwards took out a patent in October last in Melbourne for the manufacture of lime and cement from materials brought to light in excavating the Reilly-street drain at the north end of Fitzroy and East Collingwood. It is a magnesian limestone or dolomite, and appears to be a deposit overlying the basalt or bluestone of that locality. Similar deposits (although not to so large an extent as to lead me to suppose they are of any great commercial value) may be seen on the surface of the cuttings on the Government railway between Melbourne and Sunbury, also at Guildford, on the Loddon, and on the Campaspe Plains, &c.

The Collingwood limestone has been analysed, and found to contain about 52 per cent. of carbonate of lime, 18 per cent. carbonate of magnesia, 12 per cent. alumina, and 18 per cent. of silica (hydrated), combined with sand, oxides of iron and manganese, alkaline salts. &c , the silica and sand varying from 9 to 22 per cent. There is a slight variation in the appearance and analyses of different samples, but the essential properties of good cement stone were found in both the samples analysed. Magnesian limestone, containing even 5 per cent. alumina, makes excellent hydraulic lime, and this

stone contains from 11 to 12 per cent. of alumina (the distinguishing characteristic of all cement stones as opposed to lime stones), it will therefore make a good, if not a superior hydraulic lime. If cement is required to set as quickly as the Roman and Portland cements, about one-eighth, or 12½ per cent. of pure clay should be intimately incorporated, by being ground up with this stone, and well mixed in a pug mill; the material must then be dried in small pieces, calcined, and again ground, and packed in casks for the market. If a market can be found here for a first-class hydraulic lime, this limestone, without any other ingredient, if properly managed, will supply such a market.

Vicat (the celebrated French engineer, and the first authority on limes and cements) in a recent article upon magnesian limestones (which seldom contain alumina) says, that "without clay (or alumina) limes cannot be decidedly hydraulic. * * * If, then, some portions of clay be present, it might happen that a triple hydrate of lime, of alumina, and of magnesia, might be formed, which should possess all the conditions of hardness and of progression (in hardness) which characterise the best hydraulic limes." He further states that two specimens of magnesian limestone, the one containing 4, and the other 5½ per cent. of clay, gave limes possessing the hydraulic character in an eminent degree. Parandier, another French engineer of note, states that "a magnesian limestone containing 11 per cent. of clay yields a very excellent hydraulic lime." The Collingwood limestone contains from 11 to 12 per cent. of clay.*

It is well known that cement made from stone containing too much silica, swells in setting, and is therefore likely to disturb the masonry executed with it. On the contrary, those cements in which alumina is in excess, are likely to shrink and to crack. "The magnesian limestones, or dolomites, appear to be the least exposed to these inconveniences, and to retain without alteration their original bulk."†

FUEL.

I have already treated upon the manufacture of charcoal in an article on that subject, I have also referred to coke and coking under the article "Gas."

Patent Hydrocarbonic Fuel.—"On the 26th November, 1857, Messrs. J. Chaplin and J. McRae, obtained a patent in Victoria for the manufacture of hydrocarbonic fuel, by combining two parts of charcoal with one part of coal, the charcoal to be first fully impregnated with hydrogen gas, the whole to be crushed and amalgamated by the application of heat and steam, and pressed into suitable sized blocks. The patentees state that this fuel leaves no clinkers and little or no smoke, and that one ton is equal to one

* Hydraulic lime may be seen in the Victorian Exhibition, made by mixing the alumina of fireclay and *kaolin*, or these articles in their crude state, with carbonate of lime in the form of pulverised limestone.—C. Mayes, 4th November, 1861.

† *Limes, Cements, Mortar, &c.* By G. R. Burnell, C.E.

and a half tons of coal or three tons of wood, it will consequently occupy less space and is not liable to spontaneous combustion."

Application.—It appears to me that this patent could be best carried out in conjunction with the manufacture of pyroligneous acid from our hardwoods, by which means the charcoal and hydrogen gas could be obtained from the wood, simultaneously with the crude wood vinegar. (See *Pyroligneous Acid*, under the article on "Gas")*

Artificial Fuel.—"On the 30th September, 1858, Messrs. J. S. and T. Danks obtained a patent in Victoria for the manufacture of fuel from two or more or the whole of the following ingredients, viz., coals, coke, and charcoal in small pieces, or the dust of either, wood, wood sawdust, wood turnings, cuttings, shavings, and dried vegetable substances mixed intimately with pitch, resin, asphalte, wood or coal tar, naptha, turpentine, or other inflammable spirits, suet or any fatty substance, the materials to be moulded or cut into any convenient form."

The last patent appears to monopolize the application of nearly every material of an inflammable nature, and as I have been accustomed to see many of these ingredients thrown away as rubbish, and allowed to rot on our wharves and rubbish depôts, I am at a loss to know why the patent has hitherto lain dormant.

Coal Tar.—According to Dr. Ure 100 lbs. of coal tar will produce 26 lbs. of coal oil, and 48 lbs. of pitch. As there is but little demand for coal tar in Victoria it might be found profitable to convert it into coal tar oil, either to be used as a substitute for kerosene and parafine, or distilled as a substitute for naptha, in which form it is extensively used for dissolving caoutchouc in making the varnish of waterproof cloth. The pitch may be used in many ways, one of these is in the manufacture of—

Grant's Patent Fuel, which is composed of coal dust and coal tar pitch, mixed together under the influence of heat in the proportion of 20 lbs. of pitch to 1 cwt. of coal dust, by appropriate machinery which grinds, sifts, heats to 220°, mixes, and moulds by pressure the fuel into lumps the size of common bricks, these are whitewashed, which prevents them sticking together even in hot climates. The advantages of this fuel over the common coals are many : it is said to produce 50 per cent more steam ; to occupy less space ; to be used with greater ease ; to create little or no dust or dirt ; also that the ignition is so complete as to produce but little smoke and ashes : and lastly, to be not liable to enter into spontaneous combustion. *(See article* FUEL *in supplement to Dr. Ure's Dictionary of Arts, &c.)*

CHAS. MAYES, C.E.

Hawthorn, July 15th, 1861.

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* Pyroligneous acid, in its different processes of manufacture from our gum trees, may now be seen in the Victorian Exhibition.—C. MAYES, 4th November, 1861.

By Authority: JOHN FERRES, Government Printer, Melbourne